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## Assesment of Shallow Groundwater Quality for Irrigational Use in and around Berasia, M. P., India

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### ABSTRACT

Water is very important for irrigation. Farmers of the study area mostly used dug well waters for irrigational purposes. The present study mainly concerns the irrigational utility of shallow groundwater in and around Berasia area, District Bhopal, Madhya Pradesh. In order to assess the shallow groundwater quality for irrigational use, 15 shallow groundwater samples have been collected during pre monsoon and post monsoon period and analysed by using the standard procedures as suggested by APHA (1995). The analytical results were used to determine the various irrigational specifications like Sodium Adsorption ratio, Kellys ratio, Residual sodium Carbonate, Salt Index, Magnesium Hazards Adj.SAR. On the basis of various irrigational specifications, it is suggested that the majority of shallow groundwater of the study area is quite suitable for irrigational purposes.

### INTRODUCTION

Water is played most significant role in shaping the land and regulating the climate. Water is one of the main compounds that extremely influence the life. The shallow ground water is used for irrigational purposes in all around the globe. In the last few years, there has been a remarkable raise in the demand for water due to unplanned urbanization and industrialization for the past few decades in few parts of the country. The farmers of the study area are mostly using the shallow groundwater for agricultural purposes. Thus the hydro-geochemistry study is very important to keep pace with agricultural development in rural areas.

The area of present investigation falls on Survey of India Toposheet Nos. 55E/11, 55E/10, 55E/7, 55E/6, 55E/5, and is bounded between latitude 23°10' to 23°50' N and longitude 77°42' to 77° E. The important fringing rocks are the deccan traps lava flows of basaltic composition and traversed by a succession of sandstone hill of vindhyarange. The climate of the Study area has a [humid subtropical climate](#), with cool, dry winters, a hot summer and a

humid monsoon season. The soils of the study area are moderately fine textured and are clay to clay loam.

In the study area the alluvial is a rich source for groundwater occurrences. The groundwater occurs both under water table and confined condition. The alluvial aquifer system is the most extensive. The top aquifer ranges in thickness from 2 to 3 meter and comprises of fine medium grained sand with intercalations of clay and silt and at place also of coarse sand or gravel. Confined condition has resulted in places where the granular zone occurs in between clay horizons. All the aquifers are principally recharged by a lateral flow from the south and also by direct vertical percolation of rain, Irrigation water, seepage from tanks and canals.

### Material and Methods

In order to know the spatial and temporal variation in shallow groundwater quality, about 15 shallow ground water samples were collected from dug wells during Pre Monsoon and Post Monsoon period. In order to assess the potability of shallow ground waters of the study area the physical characters of the



water samples were studied at the sampling point in the field, and the chemical characters have been determined in the laboratory by using the standard procedures as suggested by APHA (1995). The chemical analysis of water samples provide important information about the environment to which natural water is exposed in the hydrologic cycle. The

concentration of major cations and anions are presented in Table-1 and 2. The chemical constituents have been converted to me/l and irrigational specifications like Salt Index, Kellys Ratio (KR), Sodium Adsorption Ratio (SAR), Soluble Sodium Percentage (SSP), Residual Sodium Carbonate (RSC) have been computed and presented in Table-3 and 4.

Table No. 1: Hydrochemistry of the study area (Premonsoon)

Well No.	Name Of the Village	pH	ECX10 <sup>6</sup> at 25 <sup>0</sup> C	TDS	CONCENTRATIONS IN MILIGRAM PER LITRE										
					CATIONS				T.H. as CaCO <sub>3</sub>	ANIONS					
					Na <sup>+</sup>	K <sup>+</sup>	Ca <sup>++</sup>	Mg <sup>++</sup>		HCO <sub>3</sub>	CO <sub>3</sub> --	Cl <sup>-</sup>	NO <sub>3</sub>	SO <sub>4</sub>	PO <sub>4</sub>
2	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	Khijradev	7.60	1400	896	36	7.6	42	12	152	150	Ab	23	75	46	0.24
2	Golkhari	7.50	820	525	36	1.6	45	20	225	180	Ab	34	80	35	0.12
3	sukha nipaniya	7.10	660	422	40	14.1	65	32	208	240	Ab	32	40	35	0.25
4	Bagonia	7.40	780	499	60	6.2	69	26	229	195	Ab	40	45	48	0.21
5	semerhari	7.20	810	518	25	3.1	58	36	306	220	Ab	45	60	46	0.18
6	Chandu khri	7.70	700	448	70	2.0	76	14	311	160	Ab	50	65	42	0.12
7	Intkeri	7.30	840	538	20	4.0	63	15	183	184	Ab	38	65	28	0.16
8	Taradi kalan	7.80	810	518	46	6.0	63	10	190	260	Ab	53	38	39	0.67
9	Habibganj	7.10	900	576	24	4.9	60	22	324	200	Ab	20	65	27	0.20
10	Kutkipura	7.40	870	557	30	3.6	42	28	193	195	Ab	34	75	36	0.35
11	Bhojapura	7.20	490	314	32	1.2	41	26	262	255	Ab	38	38	27	0.10
12	Semera	7.40	800	512	61	3.2	69	32	294	72	Ab	37	40	43	0.63
13	Bhamora	7.20	500	320	27	9.7	65	24	215	90	Ab	44	45	20	0.07
14	Imlipura	7.70	860	550	32	2.4	57	15	196	300	Ab	64	85	39	0.46
15	Pursora	7.60	440	218	30	3.6	65	18	210	190	Ab	40	76	27	0.10

Table No. 2: Hydrochemistry of the study area (Post monsoon)

Well No.	Name Of the Village	pH	ECX10 <sup>6</sup> at 25 <sup>0</sup> C	TDS	CONCENTRATIONS IN MILIGRAM PER LITRE										
					CATIONS				T.H. as CaCO <sub>3</sub>	ANIONS					
					Na <sup>+</sup>	K <sup>+</sup>	Ca <sup>++</sup>	Mg <sup>++</sup>		HCO <sub>3</sub>	CO <sub>3</sub> <sup>--</sup>	Cl <sup>---</sup>	NO <sub>3</sub>	SO <sub>4</sub>	PO <sub>4</sub>
2	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	Khijradev	7.50	1350	890	32	7.50	41	11	150	145	Ab	21	72	42	0.22
2	Golkhari	7.30	810	500	32	1.40	42	18	200	175	Ab	32	78	32	0.12
3	sukha nipaniya	7.00	650	412	38	12.10	60	30	200	210	Ab	30	38	30	0.25
4	Bagonia	7.20	770	432	58	4.20	67	25	220	180	Ab	32	42	44	0.19
5	semerhari	7.00	800	500	22	2.10	55	28	300	198	Ab	40	58	42	0.10
6	Chandu khri	7.70	680	422	65	1.70	72	32	310	140	Ab	45	60	40	0.10
7	Intkeri	7.20	810	502	20	2.00	60	9	170	170	Ab	34	60	24	2.00
8	Taradi kalan	7.60	790	498	42	4.00	60	10	180	230	Ab	50	34	13	0.10
9	Habibganj	7.10	880	525	22	4.00	58	20	320	180	Ab	18	60	25	0.32
10	Kutkipura	7.20	850	550	28	2.90	40	25	194	185	Ab	32	65	34	0.30
11	Bhojapura	7.10	470	300	30	1.00	38	23	260	240	Ab	34	38	25	0.60
12	Semera	7.20	780	448	48	3.00	65	30	280	250	Ab	35	38	32	0.63
13	Bhamora	7.00	450	300	25	8.70	60	20	225	85	Ab	23	45	18	0.07
14	Imlipura	7.50	830	525	30	2.00	52	13	180	265	Ab	42	82	35	0.36
15	Pursora	7.30	530	335	19	3.10	29	11	198	240	Ab	32	34	28	0.12

## Results and Discussion:

### Hydrochemistry of the study area:

The hydrochemistry of collected groundwater samples during the pre- monsoon and post-monsoon period are presented in Table -1 and Table-2 respectively. The pH value of groundwater of the study area varies from 7.10 to 7.80 in pre-monsoon and 7.00 to 7.70 in post-monsoon period which suggests that the water is mildly alkaline in nature. The Electrical conductivity (EC) values in groundwater varies from 440  $\mu$ mhos/cm to 1400  $\mu$ mhos/cm and 450  $\mu$ mhos/cm to 1350  $\mu$ mhos/cm in pre-monsoon post-monsoon period respectively indicating that the shallow ground water has medium to high salt concentration.

Calcium content in groundwater varies from 41 mg/l to 76 mg/l in pre-monsoon and 29 mg/l to 72 mg/l in post-monsoon periods. The Magnesium concentration in groundwater varies from 10 mg/l to 36 mg/l in pre-monsoon

and 09 mg/l to 32 mg/l in post-monsoon period.

The sodium content in groundwater varies from 20 mg/l to 70 mg/l in pre-monsoon and 19 mg/l to 65 mg/l in post-monsoon period. The Potassium content in groundwater is varies from 1.2 mg/l to 14.1 mg/l in pre-monsoon and 1.00 mg/l to 12.10 mg/l in post-monsoon period. The total hardness in terms of CaCO<sub>3</sub> ranges from 152 mg/l to 324 mg/l in pre-monsoon and 150 mg/l to 320 mg/l in post-monsoon period.

The chloride concentration in groundwater varies from 20 mg/l to 64 mg/l in pre-monsoon and 18 mg/l to 50 mg/l in post-monsoon period. The Sulphate concentration in the groundwater of the study area varies from 20 mg/l to 48 mg/l in pre-monsoon and 13 mg/l to 44 mg/l in post-monsoon period. In the present investigation, the Nitrate content in the groundwater varies from 38 mg/l to 85 mg/l in pre-monsoon and 34 mg/l to 82 mg/l in post-monsoon period. The Phosphate concentration in groundwater of the

study area varies from 0.10mg/l to 0.67 mg/l in pre-monsoon and 0.07 mg/l to 2.00 mg/l in post-monsoon period. The carbonate content is found to be absent in all the samples of groundwater, collected during the pre-monsoon and post-monsoon periods. Bicarbonate is the

predominant anion in the groundwater of the study area. Bicarbonate concentration in the groundwater varies from 72 mg/l to 300 mg/l in pre-monsoon and 85 mg/l to 265 mg/l in post-monsoon period.

**Table No. 3 : Tabulated computed data of various Irrigational specifications of shallow groundwater in pre monsson**

Well No.	Name of Village	Agricultural Utility					
		R.S.C.	K.R.	Mg%	Salt Index	Na %	SAR
1	2	3	4	5	6	7	11
1	Khijradev	-0.71	0.9	35.4	-11	33.04	1.2
2	Golkhari	-0.94	0.67	25.4	-7.2	28.3	1.2
3	sukha nipaniya	-0.62	1.12	37.5	-9	27.75	1.1
4	Bagonia	-1.73	0.56	44.3	-5.2	35.9	1.7
5	semerhari	-2.29	0.67	35.8	-2.5	14.49	1.3
6	Chandu khri	-1.33	1.62	40.7	-7.2	37.68	0.5
7	Intkeri	0.25	0.2	45.4	-2	16.24	2
8	Taradi kalan	-1.6	1.11	42.7	-9.2	33.55	0.5
9	Habibganj	-1.34	0.98	33.9	-4	17.18	1.5
10	Kutkipura	0.01	0.32	38.5	-6.4	22.87	0.6
11	Bhojapura	-1.62	0.66	47	-12.3	25.55	0.9
12	Semera	-2.28	0.48	39.6	-6.9	21.85	0.9
13	Bhamora	0.85	1.08	41.7	-13.5	35.44	0.8
14	Imlipura	-1.58	1.05	44.6	-8.3	18.99	1.6
15	Pursora	1.67	0.54	35	-10	12.52	0.9

**Table No. 4: Tabulated computed data of various Irrigational specifications of shallow Groundwater in post monsoon**

Well No.	Name of Village	Agricultural Utility					
		R.S.C.	K.R.	Mg%	Salt Index	Na %	SAR
1	2	3	4	5	6	7	11
1	Khijradev	0.05	0.8	33.45	-8	31.45	1.64
2	Golkhari	0.82	0.8	23.4	-4.5	32.43	1.23
3	sukha nipaniya	-2.13	1.16	39.5	-3.8	22.26	0.66
4	Bagonia	-2.43	0.58	47.4	-11.6	25.41	1
5	semerhari	-1.6	0.77	37.7	-12.5	18.11	0.85
6	Chandu khri	-4.02	0.48	42.4	-1.7	15.48	1.63
7	Intkeri	-0.17	0.89	49.2	-2.5	32.14	0.5
8	Taradi kalan	-1.19	0.64	43.31	-12.19	16.81	1.5
9	Habibganj	-0.87	0.23	35.01	-13.8	23.22	0.56
10	Kutkipura	-1.64	0.4	40.03	-8.4	26.94	1.5
11	Bhojapura	-0.3	0.56	45.7	-7.4	30.54	1.46
12	Semera	-1.7	0.67	37.5	-4.47	26.87	1.28
13	Bhamora	-0.39	0.84	39.1	-6.8	199.63	0.85
14	Imlipura	-0.42	0.78	43.7	-7.8	21.49	1.07
15	Pursora	-0.95	0.67	38.12	-9.3	15.66	1.44



## Irrigation Water Quality

In the present study, the specifications as proposed by Asgar et al. (1936); Kelley et al. (1940); Eaton, (1950); US Soil Salinity Laboratory Staff (1954); Wilcox (1955) and Paliwal (1972) have been used in terms of Salt Index, Kellys Ratio, Residual Sodium Carbonate (RSC), Soluble Sodium Percentage (SSP) and Sodium Adsorption Ratio (SAR), and Magnesium hazard respectively to assess the suitability of shallow groundwater for agricultural purposes. On the basis of irrigational specifications presented in Table -3 and 4, the irrigational suitability of shallow ground water have been evaluated and classified into various categories. The recommended classification of irrigation water quality with respect to EC, SAR, Kelly's Ratio, Mg. Ratio, RSC and Na% are presented in Table -5.

Asgar et al. (1936) suggested that salt index parameter evaluates the agricultural water quality. If salt index is negative, the water belongs to good category and if the salt index is positive then the water is unsuitable for irrigational purposes. In the present study, the values of all the shallow ground water samples are negative which indicates that the water is suitable for irrigation purposes.

On the basis of Kellys Ratio, the sodium problem in water can be evaluated. As per Kellys et al. (1940), if the Kelly ratio is less than one then the water is suitable, if it is between one and two then the water is marginally suitable and if it is beyond two then the water is unsuitable for irrigational purposes. In the present study, Table 3 and 4 reveals that the values of shallow ground water samples during pre and post monsoon period varies from 0.20 to 1.62 in pre monsoon and 0.23 to 1.16 in post monsoon period. Further, Table-5 indicates that the majority of shallow groundwater samples; 67% in pre monsoon

period and 93% in post monsoon period, belongs to suitable category.

Eaton (1950) recommended that indirect effect of carbonate and bicarbonate on water quality is expressed in terms of Residual Sodium Carbonate (RSC). As per U.S. Soil Salinity Staff (1956), water with less than 1.25 me/l of RSC are safe, between 1.25 and 2.5 me/l of RSC are marginal in nature and beyond 2.5 of RSC are unsuitable for irrigational purposes. Table 3 and 4 reveals that all the shallow groundwater samples of the study area have RSC values less than 1.25 which clearly indicates that these waters are quite safe and suitable for irrigational purposes.

Wilcox (1955) proposed a classification based on the values of Electrical conductivity, Boron and Soluble sodium Percentage (SSP) for assessing irrigation water. When the values of EC and SSP concentration of shallow groundwater compared with this classification, the shallow groundwater are classified as Excellent to good and good to permissible class with respect to Na% and EC values respectively.

Paliwal (1972) has utilized the term magnesium percentage ratio as an index of magnesium hazards of irrigation water. When the Mg/Ca ratio in irrigation water increases the degree of hazardous effect also increases. As per Paliwal (1972), when this ratio exceeds 50% then the magnesium hazard is likely to be developed. In the present study the magnesium % varies from 33.5 to 68.2 in pre monsoon period and 12.54 and 57.23 in post monsoon period. Table-5 reveals that majority of shallow groundwater does not have magnesium hazards. However, few of the samples have more than 50% of magnesium which have quite restriction for sensitive crops.

**Table 5: Tabular classification of Groundwater of the study area**

Irrigational Specifications	Range	Class	Type of Water			
			Pre Monsoon		Post Monsoon	
			No. of Samples	%	No. of Samples	%
EC	<250	Low	0	Nil	0	Nil
	250-750	Medium	5	33%	6	40%
	750-2250	High	10	67%	9	60%
	>2250	Very High	0	Nil	0	Nil
	<b>Total</b>		<b>15</b>	<b>100%</b>	<b>15</b>	<b>100%</b>
SAR	<10	Low	15	100%	15	100%
	10-18	Medium	0	Nil	0	Nil
	18-26	High	0	Nil	0	Nil
	>26	Very High	0	Nil	0	Nil
	<b>Total</b>		<b>15</b>	<b>100%</b>	<b>15</b>	<b>100%</b>
Kelly's Ratio	< 1	Suitable	10	67%	14	93%
	1-2	Marginal	5	33%	1	7%
	> 2	Unsuitable	Nil	Nil	Nil	Nil
	<b>Total</b>		<b>15</b>	<b>100%</b>	<b>15</b>	<b>100%</b>
Magnesium Ratio	< 50	suitable	15	100%	15	100%
	>50	Unsuitable	Nil	Nil	Nil	Nil
	<b>Total</b>		<b>15</b>	<b>100%</b>	<b>15</b>	<b>100%</b>
Residual Sodium Carbonate (RSC)	<1.25	Safe	15	100%	15	100%
	1.25-2.50	Marginal	Nil	Nil	Nil	Nil
	>2.50	Unsuitable	Nil	Nil	Nil	Nil
	<b>Total</b>		<b>15</b>	<b>100%</b>	<b>15</b>	<b>100%</b>
Salt Index	-Ve(Negative)	Suitable	15	100%	15	100%
	+Ve(Positive)	Un Suitable	0	Nil	0	Nil
	<b>Total</b>		<b>15</b>	<b>100%</b>	<b>15</b>	<b>100%</b>

## Conclusions :

On the basis of the hydrochemistry, interpretations and discussions with respect to irrigational specifications, it is concluded that the majority of shallow groundwater samples of the study area quite suitable for irrigational purpose. However few of the water sample have magnesium hazard and such water should be restricted for irrigational use.

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## FLUOROSIS AND HEALTH ASPECT IN SEHORE DISTRICT (MADHYA PRADESH)

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### 1.1 INTRODUCTION

It is well known fact that the excess fluoride intake is responsible for dental and skeletal fluorosis. The problem of fluorosis has been known in India for a long time. The disease earlier called "mottled enamel" was first reported by Vishanathan (1935) to be prevalent in human beings in Madras Presidency in 1933. Mahajan (1934) reported a similar disease in cattle in certain parts of old Hyderabad state. However, Shortt (1937) was the first to identify the disease as "Fluorosis" in human beings in Nellore district of Andhra Pradesh.

Fluoride is present in the teeth, bones, thyroid gland and skin of animals. It plays an important role on the formation of dental enamel and normal mineralization in bones but can cause dental fluorosis and adversely affect the central nervous system, bones, and joints at high concentrations (Agarwal *et al.*, 1997). The fate of fluoride in the soil environment and groundwater is of concern for several reasons. It is generally accepted that fluoride stimulates bone formation (Richards *et al.*, 1994) and small concentration of fluorides have beneficial effects on the teeth by hardening the enamel and reducing the incidence of caries (Fung *et al.* 1999). At lower levels (<2 mg/ml) soluble fluoride in the drinking water may cause mottled enamel during the formation of teeth, but at higher levels other toxic effects may be observed (Weast and Lide, 1990). Excessive intake of fluoride results in skeletal and dental fluorosis (Czarnowski *et al.* 1999). Severe symptoms lead to death when fluoride doses reach 250-450 mg/ml (Luther *et al.*, 1995). It has been found that the IQ of the children living in the high fluoride areas (drinking water fluoride > 3.15 mg/ml) was significantly lower (Lu *et al.*, 2000).

Fluoride enters in the human body mainly through the intake of water and to a lesser extent by food. The foods which are rich in fluoride include fish and tea (EPA, 1997). Ingested fluorides are quickly absorbed in the gastrointestinal tract, 35-48% is retained by the body mostly in skeletal and classified tissues, and the balance is excreted largely in the urine. Chronic ingestion of fluoride rich fodder and water in endemic areas leads to development of fluorosis in animals e.g. dental discoloration, difficulty in mastication, bony lesions, lameness, de-ability and mortality (Patra *et al.*, 2000).

Naturally occurring fluorides in groundwater are a result of the dissolution of fluoride containing rock minerals by water while artificially high soil fluoride levels can occur through contamination by application of phosphate fertilizers, sewage sludge, or pesticides (EPA 1997). Due to its strong electronegativity is attracted to positively charged calcium in teeth and bones. Major health problems caused by flouride as dental florisosis, teeth mottling, skeletal fluorosis and deformation of bones in children as well as in adults. Excess flouride affects plants and animals also. The effect on agriculture was also evident due to inhibition an plant metabolism leading to necrosis, needle scratch and tip burn diseases.

India is one among the 23 nations around the globe where health problems have been reported due to excessive fluoride in drinking water. An estimated 62 million people in India in 17 out of 28 states are affected with dental, skeletal and non skeletal fluorosis. The endemic states with the percentage area affected are given in Table 6.1.

**Table - 1.1 Indian states with areas affected by fluoride poisoning**

No.	State	Area Affected (%)
1.	Assam	-
2.	Andhra Pradesh	50 – 100
3.	Bihar	30 - 50
4.	Delhi	< 30
5.	Gujarat	50 – 100
6.	Haryana	30 - 50
7.	Jammu & Kashmir	< 30
8.	Karnataka	30 - 50
9.	Kerala	< 30
10.	Maharashtra	30 – 50
11.	Madhya Pradesh	30 - 50
12.	Orissa	< 30
13.	Punjab	30 - 50
14.	Rajasthan	50 - 100
15.	Tamil Nadu	50 - 100
16.	Uttar Pradesh	50 - 100
17.	West Bengal	-

## 1.2 SOURCES OF FLUORIDE :

Various sources of fluoride entering the body are drinking water, food, industrial exposure, drugs and cosmetics etc. However, drinking water is considered as the major contribution to fluoride entering the human body.

### 1. Drinking Water

The major source of fluoride in the groundwater is fluoride bearing rocks from which it get weathered and / or leached out and contaminates the water. Fluorides occur in three forms, namely,

fluorospars or calcium fluoride ( $\text{CaF}_2$ ), apatite or rock phosphate [ $\text{Ca}_3\text{F}(\text{PO}_4)_3$ ] and cryolite ( $\text{Na}_3\text{AlF}_6$ ). Concentration of fluorides is five times higher in granite than in basalt rock areas. Similarly, shale has a higher concentration than sandstone and limestone. Alkaline rocks contain the highest percentage of fluoride (1200 to 8500 mg/kg) (Chand, 1998).

The Geological Survey of India has brought out considerable data which reveal that fluorite, topaz, apatite, rock phosphate, phosphatic nodules and phosphorites are widespread in India and contain high percentage of fluorides.

### 2. Food

Besides water, food items especially agricultural crops are heavily contaminated with fluoride as they are grown in the areas where the earth's crust is loaded with fluoride bearing rocks. Fluoride is present to some extent in nearly all foods, but the concentrations vary widely. Studies of the fluoride contents of foodstuffs reported in the WHO Monograph (1970) have been reviewed by Muhlar (1970). Prival and Fisher and have made a more recent compilation on fluoride contents.

Among the foodstuffs notably high in fluoride are fish, particularly those, such as sardines, that are eaten with the bones. Fish-meal flour, which is produced from the whole fish, is also high in fluoride. Tea is unusually rich in fluoride. Milk and most fruits are generally low in fluoride. Vegetables vary greatly in fluoride content.

Hodge and Smith (1965) computed the total fluoride intake from food at 0.5-1.5 mg/day for areas with nonfluoridated water. Marier and Rose (1966) showed that use of fluoridated water in canneries increased the fluoride content of canned food by 0.5 mg/liter and converted this to 0.5 mg/day in the diet. The proposed total intake from the diet then became 1.0-2.0 mg/day.

However, Hodge and Smith estimate came from Machle and Largent (1943), whose values were based erroneously on earlier work (Machle *et al.*, 1942). In this earlier work the average total fluoride intake per day for 20 weeks was just under 0.5 mg with only 0.16 mg of the intake from food as such. In a more recent review Hodge and Smith (1970) have lowered their estimate 0.3-0.8 mg fluoride daily from the diet.



Recent studies indicate that the total intake of fluoride is as high as 3 mg/day rather than the earlier figure of 1.5 mg/day, primarily because of increases in the estimated levels of fluoride in foods (Spencer *et al.*, 1970). Balance data presented by Spencer also suggest a higher retention by bone, nearly 2 mg/day rather than the 0.2 rag/day indicated earlier.

Two recent articles from Spencer's group (Kramer *et al.*, 1974; Dace *et al.*, 1974) appear to support a higher estimate for dietary fluoride intake. The first is based on hospital-prepared food from 16 U.S. cities. The fluoride intake from food in the fluoridated communities was found to range from 1.6-3.4 mg/day (av. 2.6) while that from nonfluoridated cities was 0.8-1.0 mg (av. 0.9). The very high values and the marked difference between fluoridated and nonfluoridated cities can be explained in part by the inclusion of coffee and other water-based beverages as dietary intake. This classification is not usually followed by other investigators. The second article reports average fluoride intake from diets used in balance studies in a fluoridated city over a 6-yr period as 2.0 mg/day.

These findings are important because, if valid, they might represent a shift in intake that could lead to dental Fluorosis in fluoridated communities. Also, a retention of 2 mg/day would mean that an average individual would experience skeletal Fluorosis after 40 yr, based on an accumulation of 10,000 ppm fluoride in bone ash. However, these new estimates for fluoride in food are questionable; consequently, so are their implications. The values are suspect because of analytical problems. The diffusion method of Singer and Armstrong (1969a) was used with a colorimetric reagent and false high values are obtained with this technique (Taves, 1966).

A study more limited in scope, because it was restricted to 16 to 19 yr old males, found 2.0-2.3 mg/day total fluoride intake (San Filippo and Battistone, 1971). The increase over earlier values may reflect the fact that the food portions were large for the test group.

Data from balance studies in children tend to support the lower values. The dietary fluoride intake for nine children aged 4 to 18 years averaged 0.3 mg/day (Forbesero, 1973).

The quickest and most reliable method of checking whether there has been a shift in total intake of fluoride in the past 20-30 yr is through surveys of the urinary and bone fluoride concentrations occurring in people in fluoridated communities. There has been no question about the analytical techniques used in these earlier data on urine and bone because the concentrations involved were relatively high. A recent (Parkins, 1974) bone survey in Iowa done at autopsies showed bone fluoride levels higher than those in earlier publications, particularly when taking into account that they are for unashed bone, which means that the concentrations need to be approximately doubled to compare them to values for ashed bone. Detailed comparison of the method he used has shown no systematic error, but other bone fluoride values found in Rochester, New York, show concentrations which match earlier values almost exactly (Charen *et al.*, in preparation, 1976). The fluoride content in food material mainly depends upon:

1. Fluoride level in soil
2. Fluoride level in atmosphere
3. Use of fertilizers and pesticides and other sources of contamination.

The fluoride content of some food items has been given in Table 1.2

**Table : 1.2 Fluoride content in various food**

Food Item	Fluoride (mg/kg)	Food Item	Fluoride (mg/kg)
Cereals		Fruits	
Wheat	4.6	Banana	2.9
Rice	5.9	Mango	3.2

Food Item	Fluoride (mg/kg)	Food Item	Fluoride (mg/kg)
Maize	5.6	Apple	5.7
		Guava	5.1
Pulses		Beverages	
Gram	2.5	Tea	60-112
Soybean	4.0	Coconut water	0.32 - 0.6
Vegetables		Spices	
Cabbage	3.3	Coriander	2.3
Tomato	3.4	Garlic	5.0
Cucumber	4.1	Ginger	2.0
Ladyfinger	4.0	Turmeric	3.3
Ladyfinger	4.0	Turmeric	3.3
Spinach	2.0	Food from Animal sources	
Mint	4.8	Mutton	3.0 - 3.5
Brinjal (egg plant)	1.2	Beef	4.0 - 5.0
Potato	2.8	Pork,	3.0 - .5
Carrot	4.1	Fishes	1.0 - 6.5

Source : Prevention and control Fluorosis in India. Vol.1 (Health Aspects) (Ed. Susheela, A.K.) Rajeev Gandhi National Drinking Water Mission, New Delhi.

### 3 . Drug and Cosmetics

The sodium fluoride containing drugs for Osteoporosis, Osteosclerosis and dental caries are in use for many years. The prolonged use of these drugs may cause fluorosis. Additionally, the toothpastes and mouth-rinses (whether labelled fluoridated or otherwise) also contain higher fluoride concentration. The fluoride content arising from raw materials used for the manufacturing of tooth-paste, namely, calcium carbonate, talc and chalk can have as high as 800-1000 mg/kg of fluoride. In the fluoridated brands of tooth-pastes, the fluoride content has been reported up to 1000-4000 mg/kg. Moreover, some of the mouth rinses are nothing but fluoridated water of a very high fluoride concentration.

### 1.3 HEALTH IMPACTS AND FLUORIDE :

#### 1. Optimum concentration of fluoride in drinking water

According to WHO standards, the fluoride in drinking water should be within a range that slightly varies above and below 1 mg/L (Meenakshi *et al.*, 2004). In temperate regions, where water intake is low, fluoride level up to 1.5 mg/L is acceptable. The Ministry of Health, Government of India, has prescribed 1.0 and 2.0 mg/L as permissive and excessive limits for fluoride in drinking water, respectively. Table 3 shows different health impacts at varying fluoride concentrations in drinking water.

**Table 1.3 Concentration of Fluoride in drinking water and its effects on human health**

Fluoride Concentration (mg/L)	Effect
Nil	Limited growth and fertility
< 0.5	Dental caries

0.5 - 1.5	Promoters dental health, prevents tooth decay
1.5 - 4.0	Dental fluorosis (mooting and pitting of teeth)
4.0 - 10.0	Dental fluorosis, skeletal fluorosis (pain in neck bones and back).
> 10.00	Crippling fluorosis.

## 1.4 SENSITIVITY TO FLUORIDE :

A recent report (Grimbergen, 1974) suggests confirmation of the earlier claims by Waldbott (1962) that some people are very sensitive to fluoride. Waldbott's claims have been dismissed on two grounds: that he was the only one to report such effects, and that sensitivity of this type has not been reported among the-billions of tea drinkers in the world who would be ingesting extra fluoride (WHO, 1970, p. 15).

Grimbergen's report was a preliminary methodological paper and is not convincing. Two aspects of the methodology seem weak and could lead to erroneous conclusions. First, when large numbers of double-blind tests are done, it is to be expected that control patients will occasionally have symptoms that correspond to those associated with the administration of fluoride; the investigator should indicate the rate of positive responses and the results of retesting. Second, the patients selected themselves for inclusion in the study based on their beliefs that they were already sensitive to fluoride. Waldbott's case reports (1962) are more completely documented and he used concentrations that were probably too low to be identified by taste. He reported 29 positive responders among 48 people tested. The Royal College of Physicians (1976, p. 63) review stated that sodium fluoride at 1 mg/15 ml of distilled water has a distinctive taste. However, Taves (unpublished, 1976) found that four people out of five could not tell the difference at 1 mg/15 ml.

Waldbott and Grimberger are not the only ones who have described patients with syndromes that they explained as intolerance to fluoride. Douglas (1947) tested 32 patients in a group of 133 with histories suggestive of sensitivity to

fluoride-containing dentifrices. He implied that none were able to complete a series of six alternating trials using fluoride and nonfluoride toothpastes, because of intolerance, mainly in the form of ulcerations of the mouth. Feltman and Kosel claimed that, among pregnant mothers and their children, 1% (at least four of them) reacted adversely to 1 mg fluoride tablets. They stated that they established (by means of placebos) that it was the fluoride, rather than the binder, that caused the adverse effect (Feltman, 1956; Feltman and Kosel, 1961). Shea, Gillespie, and Waldbott (1967) reported on seven cases of patient improvement after discontinuing vitamin drops or toothpaste containing fluoride. They subjected one case to a double-blind.

Study with sodium fluoride in the cases involving toothpaste, the associated cation is not stated. Stannous fluoride is commonly used in toothpaste; therefore, sensitivity to tin, rather than to fluoride, cannot be ruled out. Petraborg (1974) reported on seven case histories of what seemed to be fluoride sensitivity, but the patients were not subjected to objective tests, so the evidence is weak.

The quantities of fluoride involved are clearly relevant to the question of the safety of fluoridation. But, if Feltman and Kosel's estimate of 1% intolerant people is correct, there should have been more reports of adverse effects in the studies in which fluoride tablets were given to school going children (at least 10,000 children by 1967, mainly in Switzerland) (O'Meara, 1968). Also, as methoxyflurane anesthesia for surgery typically causes serum fluoride content to increase to 30-50 times normal (Fry *et al.*, 1973), there should have been striking cases of such intolerance in an estimated 12 million patients who have received methoxyflurane (NAS-NRC, 1971). Moreover, cases of intolerance to fluoride (20-100 mg/day) for osteoporosis have been associated with very few symptoms of the type reported by Waldbott. There have not been reports of intolerance from people who move into and out of numerous towns with naturally high fluoridated water supplies. Opportunities for such discovery existed before any bias for or against fluoridation.

So, although sensitivity to fluoride has not been demonstrated firmly, a possibility of

sensitivity or idiosyncratic reaction to fluoride should be kept in mind. Clarification might come from two kinds of study. Studies on the administration of fluoride drops or tablets for prevention of dental caries should include consideration of possible intolerance and definite statements should be made about any findings in this regard; in most such reports, no comments are made about a search for intolerance. Quibbles and Suttie (1972) have demonstrated an ability of fluoride-resistant cells to remove or exclude fluoride from their interiors *in vitro*. Humans or animals receiving fluoride for long periods should be studied to see whether a cellular resistance develops *in vivo*. If this could be demonstrated, the metabolic consequences of resistance or its absence might shed light on how intolerance could occur.

## 1.5 VARIOUS FORMS OF FLUOROSIS :

The various forms of fluorosis arising due to excessive intake of fluoride are briefly discussed below:

### 1. **Dental fluorosis**

This form of fluorosis affects the teeth and mainly occurs in children. The natural shine or lustre of the teeth disappears. In the early stage, the teeth appear chalky white and then gradually become yellow, brown or black. The discoloration will be horizontally aligned on the tooth surface as lines" or „soots" away from the gums. Tiny pits or perforations can be seen in the form of cavities on the surface of teeth. Dental fluorosis affects both the inner and the outer surface of the teeth. One can become edentulous even as much younger age in the fluoride endemic areas. The disease has mostly cosmetic implications and has no treatment.

#### **Dental fluorosis**

**Dental fluorosis** is a health condition caused by the critical period of exposure is between 1 to 4 years of ages children over a child age 8 are not at risk. In its mild form, which is the most common, fluorosis appears as tiny white streaks or specks that are often unnoticeable. In its severe form it is characterized by black and brown stains, as well as cracking and pitting of the teeth.

The severity of dental fluorosis depends on the amount of fluoride exposure, the age of the child,

individual response, nutritional and other factors. Although water fluoridation can cause fluorosis, most of this is mild and not usually of aesthetic concerns severe cases can be caused by exposure to water that is naturally fluoridated to levels well above the recommended levels, or by the exposure to other fluoride sources such as brick tea or pollution from high fluoride coal.

### **Physiology**

Dental fluorosis occurs because of the excessive intake of fluoride either through fluoride in the water supply, naturally occurring or added to it; or through other sources. The damage in tooth development occurs between the ages of 3 months to 8 years, from the overexposure to fluoride. Teeth are generally composed of hydroxyapatite and carbonated hydroxyapatite; when fluoride is present, fluorapatite is created. Excessive fluoride can cause white spots, and in severe cases, brown stains or pitting or mottling of enamel. Fluorosis cannot occur once the tooth has erupted into the oral cavity. At this point, fluorapatite is beneficial because it is more resistant to dissolution by acids (demineralization). Although it is usually the permanent teeth which are affected, occasionally the primary teeth may be involved.

The differential diagnosis for this condition may include Turner's hypoplasia (although this is usually more localized), some mild forms of amelogenesis imperfecta, and other environmental enamel defects of diffuse and demarcated opacities.

### **Dean's Index**

H.T. Dean's fluorosis index was developed in 1942 and is currently the most universally accepted classification system. An individual's fluorosis score is based on the most severe form of fluorosis found on two or more teeth.

### 2. **SKELETAL FLUOROSIS :**

Skeletal fluorosis affects the bones/skeleton of the body. Skeletal fluorosis can affect both young and old alike. One can have aches and pain in the joints. The joints which are normally affected by skeletal fluorosis are neck, hip, shoulder and knee that makes it difficult to walk and movements are painful. Rigidity or stiffness of joints also sets in. More worrisome is that skeletal fluorosis is not easily

detectable until the disease attains an advanced stage. In severe cases, there is a complete rigidity of the joints resulting in stiff spine, called as „*Bamboo spine*“ and immobile knee, pelvic and shoulder joints.

## Skeletal fluorosis

**Skeletal fluorosis** is a bone disease caused by excessive consumption of fluoride. In advanced cases, skeletal fluorosis causes pain and damage to the bones and joints.

## Causes

Common causes of fluorosis include inhalation of fluoride dusts/fumes by workers in industry, use of coal as an indoor fuel source (a common practice in China), consumption of fluoride from drinking water (naturally occurring levels of fluoride in excess of the CDC recommended safe levels and consumption of fluoride from the drinking of tea, particularly brick tea.

In India, the most common cause of fluorosis is fluoride-laden water derived from deep

bore wells. Over half of the ground water sources in India have fluoride above recommended levels.

## Epidemiology

In some areas, skeletal fluorosis is endemic. While fluorosis is most severe and widespread in the two largest countries i.e. India and China. UNICEF estimates that "fluorosis is endemic in at least 25 countries across the globe. The total number of people affected is not known, but a conservative estimate would number in tens of millions.

The World Health Organization recently estimated that 2.7 million people in China have the crippling form of skeletal fluorosis. In India, 20 states have been identified as endemic areas, with an estimated 60 million people at risk and 6 million people disabled; about 600,000 might develop a neurological disorder as a consequence.

Symptomatic skeletal fluorosis is almost unknown in the U.S. with about a dozen of cases reported.

**Table No. 1.4**  
**Skeletal fluorosis phases**

Osteosclerotic phase	Ash concentration (mgF/kg)	Symptoms and signs
Normal Bone	500 to 1,000	Normal
Preclinical Phase	3,500 to 5,500	Asymptomatic; slight radiographically-detectable increases in bone mass
Clinical Phase I	6,000 to 7,000	Sporadic pain; stiffness of joints; osteosclerosis of pelvis and vertebral spine
Clinical Phase II	7,500 to 9,000	Chronic joint pain; arthritic symptoms; slight calcification of ligaments' increased osteosclerosis and cancellous bones; with/without osteoporosis of long bones
Phase III : Crippling Fluorosis	8,400	Limitation of joint movement; calcification of ligaments of neck vertebral column; crippling deformities of the spine and major joints; muscle wasting; neurological defects/compression of spinal cord

Field photograph showing prominently in later part of age i.e. above 50 years.



### 3. NON-SKELETAL MANIFESTATIONS :

The soft tissues of the body may be affected by excessive consumption of fluoride. The symptoms include gastro-intestinal complaints, loss of appetite, pain in stomach, constipation followed by intermittent diarrhoea. Muscular weakness and neurological manifestations leading to excessive thirst tendency to urinate more frequently are common among the afflicted individuals. Cardiac problems may arise due to cholesterol production. Repeated abortions or still birth, male infertility due to sperm abnormalities are also some of the complications. None of the Cases in observed in the area of study.

#### 1.5 PREVENTION OF FLUOROSIS :

Excessive fluoride ingestion by human beings can be prevented by using the following approaches:

##### (i) Using alternate water sources:

Alternate water sources include surface water, rainwater and low-fluoride groundwater. **Improving the nutritional status of population at risk:**

Adequate calcium intake is directly associated with a reduced risk of dental fluorosis. Vitamin C ingestion also safeguards against the risk of fluorosis.

(ii) **Defluoridation:** Removing excess fluoride from drinking water using different techniques such as Nalgonda method. This defluoridation method is based on the combined use of alum and lime in a two-step process

**Table No. 1.5**  
**Dean's Index**

Classification	Criteria - description of enamel
Normal	Smooth, glossy, pale creamy -

**Table No. 1.6**

**Dietary reference intake for fluoride**

Age Group	Reference weight Kg. (lb)	Adequate intake (mg/day)	Tolerable upper intake (mg/day)
Infants 0-6 months	7(16)	0.01	0.7

	white translucent surface
Questions	A few white flecks of white spots
Very mild	Small opaque, paper white areas covering less than 25% of the tooth surface.
Mild	Opaque white areas covering less than 50% of the tooth surface
Moderate	All tooth surfaces affected; market wear on biting surfaces; brown stain may be present
Severe	All tooth surfaces affected; discrete or confluent pitting; brown stain present.

#### Prevalence

As of 2005 surveys conducted by the National Institute of Dental Research in the USA between 1986 and 1987 and by the Center of Disease Control between 1999 and 2002 are the only national sources of data concerning the prevalence of dental fluorosis.'

In the area of study dental fluorosis is more prominent: field photographs are showing sedentarily of dental fluorosis in different age group.

The condition is more prevalent in rural areas where drinking water is derived from shallow wells or hand pumps. It is also more likely to occur in areas where the drinking water has a fluoride content of more than 1ppm (part per million), and in children who have a poor intake of calcium.

Age Group	Reference weight Kg. (lb)	Adequate intake (mg/day)	Tolerable upper intake (mg/day)
Infants 7-12 months	9(20)	0.5	0.9
Children 1-3 years	12(29)	0.7	1.3
Children 4-8 years	22(48)	1.0	2.2
Children 9-13 years	40(88)	2.0	10
Boys 14-18 years	64(142)	3.0	10
Girls 14-18 years	64(142)	3.0	10
Males 19 years and over	76(166)	4.0	10
Female 19 years and over	61(133)	3.0	10

Fluoride consumption can exceed the tolerable upper limit when someone drinks a lot of fluoride containing water in combination with other fluoride sources, such as swallowing fluoridated toothpaste, consuming food with a high fluoride content, or consuming fluoride supplements. The use of fluoride supplements as a prevention for tooth decay is rare in areas with water fluoridation, but was recommended by many dentists in the UK until early 1990s. Coal burning can pollute air with fluoride: indoor air with approximately 60 ug F/m<sup>3</sup> and drinking water with 3.6 mg F/L are similarly toxic to developing permanent teeth.

Dental fluorosis can be prevented by lowering the amount of fluoride intake below the tolerable upper limit.

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## Treatment

Dental fluorosis can be cosmetically treated by a dentist. The cost and success can vary significantly depending on the treatment. Tooth bleaching, microabrasion, and conservative composite restorations or porcelain veneers are commonly used treatments. Generally speaking, bleaching and microabrasion are used for superficial straining, whereas the conservation restorations are used for more unaesthetic situations.

Following villages namely Ramkheri, Mahoriya, Phutibawari, Hasnabad Jahangirpura, Kauriya, Ujarkhera Pipliyaminan Barkhedri, most of

the children are affected by dental fluorosis, some adults are facing pain problems field photographs showing different type of dental carries.

## Field photographs –



52 yrs. man affected by skelton fluorosis Mahoria



## CONCLUSION

**Deals fluoride and Health :-** Fluoride concentration in drinking water plays a critical role in human health. In take of excess fluoride through drinking water causes fluorosis in human which can not be clinically treated. Fluorosis in initial stages causes body pains, yellowing of teeth and subsequently skeletal deformity. Out of 57 samples eight villages namely Ramkheri, Mahoriya, Kuuriya, Pipliyamiran, Berkheri, Hasuabad, Jahangirpur and Tyarkhera peoples are affected by mainly dental and skeletal fluorosis, children up to the age of 10 years mainly affected by dental fluorosis while age group of 45-55 affected by skeletal fluorosis.

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## ANHARMONIC ELASTIC PROPERTIES OF CESIUM IODIDE

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### ABSTRACT

The anharmonic elastic properties of cesium iodide are calculated using a three-body interaction potential. This includes the prediction of third order elastic constant (TOEC), Fourth order elastic constant (FOEC) and pressure derivatives second order elastic constant (SOEC) and third order elastic constant (TOEC). The experimental and theoretical results are in good agreement.

### INTRODUCTION

There are many of the crystal properties which cannot be explained without including the anharmonic Contributions arising from the potential energy expressions. Cesium iodide is an inorganic compound with the formula CsI. Bulk cesium iodide crystals have the cubic CsCl crystal structure but the structure type of nano thin CsI film depends on the substrate material – It is CsCl for mica and NaCl and NaI substrates.

Cesium iodide atomic chains can be grown inside double-wall carbon nano tubes. In such chains atom appear brighter than Cs atoms in electron micrographs despite having a smaller mass. This difference was explained by the charge difference between Cs atoms (positive), inner nano tubes (negative) and I atoms (negative). As a result, Cs atoms are attracted to the walls and vibrate more strongly than I atoms, which are pushed toward the nanotube axis.

An important application of Cesium iodide crystals, which are scintillators, electromagnetic calorimetry in experimental particle physics. The crystal properties are the thermal expansion, the specific heat beyond  $3R$  ( $R$  is the gas constant) the thermal conductivity and higher order elastic constants and their pressure and temperature variations among them are of special interest because they are related to all the anharmonic properties of solids. The coefficient of first order anharmonic term in the multi-pole interaction potential determines the anharmonic

properties such as thermal expansion pressure dependence of SOECs etc. The thermal expansion produces the difference between the adiabatic and isothermal elastic constant which provide physical insights into the nature of bonding and interatomic forces in solids. Several investigators (1-7) have studied the Third order elastic constant (TOEC) and pressure derivatives second order elastic constant (SOEC) using both two-body (1-3) and three-body (4-7) potentials. The latter potentials have given their prediction better than those revealed by other potential (1-3). Elastic constants are measured by Lundqvist Potential (8) Singh and Verma (9) Karlsson (10). In the present paper, we have used three-body potential to explain the anharmonic properties of cesium iodide.

Calculations have been performed using the expression for the third and fourth order elastic constant given by Verma and co-workers (4) and those for the pressure derivatives of SOE constants are given by Garg et al (5) respectively. The essential theory and calculations are given in section 2. The results are presented and discussed in section 3.

### 2. THEORY AND METHOD OF CALCULATIONS:

Interaction potential energy of rock salt structure solid with contribution from the long-range coulomb and three-body interactions and the short-range repulsive and van der Waals dipole-dipole and dipole –quadrupole attractions is given by



$$W(r) = \frac{amZ(Z+6 f(r))}{r} + [W_1(r) + W_2(r)] e^2 \quad (1)$$

First term is the Coulomb interaction with  $a$  as the Madelung constant,  $Z$  is the ionic charge and  $e$  is the electronic charge. Here  $r$  ( $=r_0$ ) and  $r_1$  ( $=2r_0$ ) are the first and second neighbor distances.  $f(r)$  is the three-body force parameter dependent on  $r$ .  $W_1$  and  $W_2$  are the short-range interactions defined as

$$W_1(r) = \frac{b\beta}{e^2\beta^{++}} \exp(r_+ + r_-) / r_+ - C_+ / r_6 - d_+ / r_8 \quad (2)$$

$$W_2(r) = \frac{b\beta}{e^2\beta^{++}} \exp(2r_+ + r'_+) / r_+ + b\beta^{--} / e^2 \exp(2r_- - r'_-) / r_- - (c_{++} + c_{--}) / r_+^6 - (d_{++} + d_{--}) / r_+^8 \quad (3)$$

$$\text{Where } \beta_{ij} = 1 + (z_i/n_i) + (z_j/n_j) \quad (4)$$

With  $n_i$  as the number of electrons in outermost orbit. Here,  $b$  and  $\beta$  is the repulsive strength and hardness parameters, respectively. In our calculations value of ionic radii ( $r_i$ ) and van der Waals coefficients ( $c_{ij}$  and  $d_{ij}$ ) have been taken from Singh(9) and co-workers(11-22). The values of  $\beta_{ij}$  for the Cesium iodide have been taken from Hafemeister and Flygare(23). The values of  $b$  for them have been evaluated from the equilibrium condition

$$dW(r) / dr = 0 \text{ at } r=r_0 \quad (5)$$

Using the values of  $f(r)$  obtained from the knowledge of overlap integral and its derivatives from the knowledge of overlap integral (5).

$$f(r_0) = f_0 \exp(-r_0) = \epsilon_+ - S_+ - 2 \quad (6)$$

$$\text{With } f_0 = A_+ - (1 - 2r_+/r_0) \quad (7)$$

Values of overlap integral ( $S_+$ ) and constants ( $A_+$ ) are directly taken from (14). Values of parameters ( $\beta_{ij}$ ,  $b$  and  $f_0$ ) have been given in Table 3.2 together with the equilibrium nearest neighbor distance  $r_0$ , which is the only input data used for the calculation of the parameter  $b$ .

### 3. RESULT AND DISCUSSIONS

TABLE: 3.1 Values of input for ionic crystal.

CRYSTAL (CsI)

$r_0$	10-8 cm (a)
$r_+$	10-8 cm (b)
$r_-$	10-8 cm (b)
$C_{11}$	1010 dyne/cm <sup>2</sup> (a)
$C_{12}$	1010 dyne/cm <sup>2</sup> (a)
$C_{44}$	1010 dyne/cm <sup>2</sup> (a)

Table 3.2 Model Parameters for ionic solids

CRYSTAL.  $b$  (in 10<sup>-12</sup> erg)  $f(r)$

CsI	0.232	0.14	-000014
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Table 3.3 Third order elastic constants (TOECs) 1011 dyne/cm<sup>2</sup> for ionic crystals.

Crystal  $C_{111}$   $C_{112}$   $C_{166}$   $C_{123}$   $C_{144}$   $C_{456}$

CsI	-3.22	-1.41	-1.42	-1.31	-1.30	-1.22
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Table-3.4 Calculated values of fourth order elastic constants (FOECs) (in 1011 dyne/cm<sup>2</sup>) for ionic Crystals.

Crystal  $C_{1111}$   $C_{1112}$   $C_{1166}$   $C_{1122}$   $C_{1266}$   $C_{4444}$   
 $C_{1123}$   $C_{1144}$   $C_{1244}$   $C_{1456}$   $C_{4466}$

CsI	33.58	7.87	7.91	8.78	8.80	8.81	8.00
	7.18	7.20	7.01				

Table 3.5 Pressure Derivatives of Second Order Elastic Constants (SOECs) (108 dyne /cm<sup>2</sup>).

Crystal dc' 44 /dp ds' /dp dk'/dp

Csl 2.36 0.57 6.589

Table 3.6: Calculated values of pressure derivatives of third order elastic constants (TOECs).

Crystal's dc 111/dp dc 112/dp dc 116/dp dc 123/dp dc 144/dp dc 456/dp

Csl -76.57 -47.69 -43.57 -44.48 -46.20 -44.10

The model parameters listed in Table 3.1 have been used to evaluate the various –order derivatives of the short-range interactions.  $A_i$ ,  $B_i$ ,  $C_i$ ,  $D_i$  ( $i=1, 2$ ). Those parameters are the same as those defined by Verma and

Coworkers (4) except for the difference that we have included the effect of short range Vander Waals attraction and represented the overlap repulsion by the HF potential. With the knowledge of parameters and input data we have calculated the values of third, fourth order elastic constants using their relevant expressions reported (4, 5).

Results obtained in the table are in good agreement with the experimental results which shows that the agreement between experimental and our theoretical results are better.

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## Stress Analysis of Academicians of Management Institutes of Kolhapur District

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### ABSTRACT

Stress is a state of psychological and physiological imbalance resulting from the disparity between demands and the ability to meet those demands on individuals. The following objectives of the study are (i) To measure level of stress of the teachers in management institutes (ii) To evaluate the impact of stress on physiological, psychological and behavioural aspects of the teachers in the management institutes (iii) To study various techniques used by teachers to overcome stress. (iv) To give suggestions there on. Descriptive research design is followed for this study. The data is collected from the primary sources. Non- probability convenience sampling technique is used to select a sample of 24 management teachers including head of the department, professors, associate professors and assistant professors of Kolhapur District. The following tools were employed to analyse the data like (a) Percentage Analysis (b) Henry Garrett Ranking (c) Two way ANOVA. The study concluded that the stress is growing at a rapid pace day by day especially when it comes at work place. The major causes of distress of the teachers are problems related with work place. It is also found that compared to male respondents female respondents are having higher level of stress whereas age remains an insignificant variable.

### 1. INTRODUCTION

Twentieth century is titled as the age of 'speed'. Certainly, there has been an explosion of information in all areas of human activity and a rapid dissemination of knowledge. The result has been a growth in expectations as well which has affected individuals at micro and macro levels and leads to stress. Stress has been substantially found in life of even a common man. No one if escaped from the trap of stress and to a certain extent it is good also. Kelly McGonigal has rightly quoted- "How you think about stress- matters!" Stress is a common experience of people when any demands are placed on them by their work or personal environment. Even though stress is a much studied concept, it is still not understood correctly and thus surrounded by confusion.

#### i. Stress

Stress is the psychological, physiological and behavioural response by an individual when they

perceive a lack of equilibrium between the demands placed upon them and their ability to meet those demands, which, over a period of time, leads to ill-health. (S. Palmer, 1989)

"Stress is a demand made upon the adaptive capacities of the mind and body" - David, Fontana. (1989).

Stress is man's adaptive reaction to an outward situation which would lead to physical, mental and behavioral changes. Even though stress kills brain cells, not all stresses are destructive in nature. Appropriate amount of stress can actually trigger passion for work, tap latent abilities and even ignite inspirations.

#### ii. Stress at workplace

Pressure at the workplace is unavoidable due to the demands of the contemporary work environment. Pressure perceived as acceptable by an individual,

may even keep workers alert, motivated, able to work and learn, depending on the available resources and personal characteristics. However, when that pressure becomes excessive or otherwise unmanageable it leads to stress. Stress can damage an employees' health and the business performance.

Work-related stress can be caused by poor work organisation (the way we design jobs and work systems, and the way we manage them), by poor work design (for example, lack of control over work processes), poor management, unsatisfactory working conditions, and lack of support from colleagues and supervisors. Research findings show that the most stressful type of work is that which values excessive demands and pressures that are not matched to workers' knowledge and abilities, where there is little opportunity to exercise any choice or control, and where there is little support from others.

## 2. OBJECTIVES OF THE STUDY

The main objectives of the study are as follows:

- i. To measure level of stress of the teachers in management institutes.
- ii. To evaluate the impact of stress on physiological, psychological and behavioural aspects of the teachers in management institutes
- iii. To study various techniques used by teachers to overcome stress.
- iv. To give suggestions there on.

## 3. LIMITATIONS

- i. The study is restricted to Kolhapur District.
- ii. The study is based on teacher's perception and their current experiences which may change in the days to come.

## 4. RESEARCH METHODOLOGY

- i. **Research Design**  
Descriptive research is used for the study as it involves fact- finding enquires related to stress aspect of teachers of

management institutes of Kolhapur District

- ii. **Sampling Design**

Convenient sampling method is used for the purpose of collecting data.

- iii. **Sample Size**

Primary data has been collected from 30 teachers of Management institutes including head of the department, professors, associate professors and assistant professors and visiting teaching staff.

- iv. **Tools for analysis**

- Simple percentage analysis
- Average range
- Standard Deviation
- Two way ANOVA
- Henry Garrett Ranking

## 5. HYPOTHESES

- i. Genders have no significant effect on level of stress.
- ii. Age have no significant effect on level of stress.
- iii. Gender and age interaction will have no significant effect on stress.

## 6. DATA ANALYSIS AND INTERPRETATION

### A. CLASSIFICATION OF THE RESPONDENTS

The following table is prepared to classify the respondents for the further analysis. In the table respondents are classified on the basic of demographic factor like age, gender, marital status, education, experience and designation. It is observed from the table that the majority of the respondents belong to the age 30-39 years of age group whereas the least respondents are from the age group of 25-29 years. It is also observed that male respondents are double in number as compared to the female respondents.



## Between-Subjects Factors

	Value Label	N
AGE	25-29	2
	30-39	14
	40-49	11
	50-54	3
	Total	30
GENDER	MALE	20
	FEMALE	10
STATUS	MARRIED	27
	SINGLE	3
EDUCATION	MBA	4
	ENGG AND	6
	MBA AND	2
	DIPLOMA	2
	M.COM AND	9
	MBA	7
	M.PHIL	12
	Ph. D	5
	5-10 YEARS	7
	10-15 YEARS	3
EXPERIENCE	15-20 YEARS	3
	20-25 YEARS	3
	25 YEARS AND ABOVE	10
	ASSISTANT PROFESSOR	9
	ASSOCIATE PROFESSOR	3
	PROFESSOR	4
	HOD	4
DESIGNATION	VISITING	4

TABLE NO.1

## Descriptive Statistics LEVEL OF STRESS

GENDER	AGE	Mean	Std. Deviation	N
MALE	25-29	18.0000	.	1
	30-39	16.7500	5.84930	8
	40-49	11.8889	2.80377	9
	50-54	14.0000	.00000	2

	Total	14.3500	4.68227	20
FEMALE	25-29	27.0000	.	1
	30-39	22.8333	6.08002	6
	40-49	18.5000	2.12132	2
	50-54	16.0000	.	1
	Total	21.7000	5.55878	10
Total	25-29	22.5000	6.36396	2
	30-39	19.3571	6.51161	14
	40-49	13.0909	3.72705	11
	50-54	14.6667	1.15470	3
	Total	16.8000	6.03095	30

TABLE NO. 2

It is observed from the above table, both male and female respondents from the 25- 29 years of age group are having higher level of stress. When compared on the basis of gender, level of stress is higher in female respondents then male respondents.

## Tests of Between-Subjects Effects Dependent Variable: LEVEL OF STRESS

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model <sup>a</sup>	563.078 <sup>a</sup>	7	80.4409	3.59	.010
Intercept	4773.565	1	4773.565	213.573	.000
GENDER	127.516	1	127.516	5.705	.026
AGE	157.960	3	52.6533	2.356	.100
GENDER * AGE	15.799	3	5.2663	.236	.871
Error	491.722	22	22.351		
Total	9522.000	30			
Corrected Total	1054.800	29			

a. R Squared = .534 (Adjusted R Squared = .385)

TABLE NO. 3

B. HYPOTHESES TESTING BY ANOVA

- i. Genders have no significant effect on level of stress.

**Interpretation:** Considering gender as first factor, from the above table shows p value is 0.026 which is less than 0.05, i.e. 5% level of confidence. So, we reject the hypothesis that gender has no significant effect on level of stress. It can be concluded as gender of the respondents has significant effect on level of stress and there is a 2.6% chance of getting higher level of stressed by random chances.

- ii. Age have no significant effect on level of stress.

**Interpretation:** Here second factor is age. From the above table calculated p value is 0.10 which is greater than 0.05, i.e. 5% level of confidence. So, here hypothesis cannot be rejected. Hence we accept hypothesis that age has no significant effect on level of stress.

- iii. Gender and age interaction will have no significant effect on level of stress.

**Interpretation:** P value for interaction of gender and age is 0.871 which is greater than 0.05, i.e. 5% level of confidence. So here hypothesis is accepted and it is said that gender and age in combination have no impact on level of stress.

## C. CAUSES OF DISTRESS BY HENRY GARRETT RAKING METHOD

### RANKING THE CAUSES OF DISTRESS

S. No	Causes	Total Score	Mean Score	Rank
1	Personal Problems	1320	44.00	IV
2	Family Problems	1505	50.17	II

3	Financial Problems	1500	50.00	III
4	Social Problems	1260	42.00	V
5	Official Problems	1915	63.83	I

TABLE NO. 4

It is observed from the above table that official problems or the problems related with work place are the major causes of distress and thus ranked on the first position followed by family and financial problems as second and third position respectively. Similarly personal and social problems are placed on fourth and fifth position of raking.

## 7. FINDINGS

- The study reveals Female teachers are having higher level of stress as compared to male teachers.
- From the study, it was also found that age has no significant effect on level of stress.
- Impact of Interaction of age and gender also remain insignificant on level of stress.
- Work place related problems are the major stressor followed by family problems and financial problems.

## 8. SUGGESTIONS

- Stress can be avoided or reduced by sharing problem with the colleagues, family members and friends.
- Teachers belonging from the age group of 25- 29 years can engage themselves in learning at workplace from their seniors.

## 9. CONCLUSIONS

Stresses are an inescapable part of most people's lives and especially work life. People working

in Institutes imparting education are also a part to it. The present study title “Stress analysis of Academicians of Management Institutes of Kolhapur District” was conducted with the selected teachers of management institutes as respondents. The main finding of the study shows that female teachers are having high level of stress. Main reasons for stress are managing personal and professional life, relationship with other employees and recognition of work in the organisation. It was also found that official and family problems are the main reasons of stress for all the respondents.

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## स्वामी विवेकानन्द के अनुसार योग की अवधारणा

जयप्रकाश शाक्य

महाराजा कॉलेज छतरपुर (मध्य प्रदेश)

विभिन्न योगियों में स्वामी विवेकानन्द ही ऐसे एकमात्र योगी हैं जिन्होंने योग को क्रियात्मक ढंग से प्रस्तुत किया। स्वामी विवेकानन्द व्यक्तिगत मोक्ष प्राप्ति का उद्देश्य न लेकर सम्पूर्ण विश्व के मोक्ष प्राप्ति की इच्छा रखते थे। स्वामी विवेकानन्द के अनुसार “योग ही वह दर्शन है जिसके द्वारा ईश्वर प्राप्ति क्रियात्मक रूप से ज्ञात होती है, दूसरे शब्दों में योग सीखना नहीं बल्कि करना है।”<sup>1</sup> वे मानते हैं कि निःस्वार्थ भावना से ईश्वर समन्वय ही योग है। विवेकानन्द के अनुसार “वहिविज्ञान के अन्तर्गत बाह्य विषयों पर मन को एकाग्र करना पड़ता है तथा अन्तर्विज्ञान के अन्तर्गत मन की गति को आत्मा की ओर उन्मुख करना पड़ता है। मन की इस एकाग्रता को योग कहते हैं।”<sup>2</sup> वे कहते हैं कि “न प्रजमा धनेन त्यागेनैके अमृतत्वमानूशः”<sup>3</sup> अर्थात् न तो सन्तति द्वारा और न सम्पत्ति द्वारा बल्कि त्याग द्वारा ही अमरत्व की प्राप्ति होती है। योग ही वह साधन है जिसके द्वारा व्यक्ति समस्त बन्धनों से मुक्त होकर ईश्वर प्राप्ति या मोक्ष प्राप्ति करता है। स्वामी विवेकानन्द के अनुसार सम्पूर्ण विश्व या प्रकृति की उन्नति करना ही योग है इसके लिए मन की एकाग्रता आवश्यक है। उन्होंने समस्त विश्व की उन्नति के लिए चार क्रियात्मक आध्यात्मिक योग मार्ग बताये हैं।

1. कर्मयोग      2. ज्ञानयोग      3. राजयोग
4. भक्तियोग

**1. कर्मयोग** —स्वामी विवेकानन्द के अनुसार “निस्वार्थ कर्म द्वारा मानव जीवन के चरम लक्ष्य मुक्ति को प्राप्त करना ही कर्मयोग है।”<sup>4</sup> कर्मयोग एक धर्म एवं नीतिशास्त्र है। कर्म व्यक्ति जीवन पर्यन्त करता है और इसे ही वह अपना कर्त्तव्य समझता है क्योंकि यह उसके लिए कल्याणप्रद है और इसी के द्वारा अपने लक्ष्य की प्राप्ति

होती है। स्वामी विवेकानन्द कहते हैं कि “जिस कर्म द्वारा हम भगवान की ओर आकृष्ट होते हैं उसे सत्कर्म कहते हैं और उसी कर्म को करना अपना कर्त्तव्य समझते हैं और जिस कर्म द्वारा पतित होते हैं उसे असत् कर्म कहते हैं उसे करना अपना कर्त्तव्य नहीं समझते हैं।”<sup>5</sup> वे मानते हैं कि कर्त्तव्य वही श्रेष्ठ होता है। जिसे बखूबी निभाया जाये। कोई भी कर्म उच्च या नीच नहीं होता बल्कि उसे करने का ढंग ही उच्च या निम्न होता है। कर्त्तव्य तो सभी श्रेष्ठ होते हैं। उन्नति का सर्वोत्कृष्ट मार्ग है कि जो कर्त्तव्य हमारे संमुख है पहले उसे किया जाये फिर धीरे-धीरे कर्त्तव्यों को करते हुए शक्ति का संचयन किया जाये और सर्वोच्च अवस्था प्राप्त की जाये। कर्म चाहे निन्दित हो या अपवित्र परन्तु कर्त्तव्य सदैव महान् ही होता है। प्रत्येक कर्त्तव्य कोई न कोई योग अवश्य है। अनासक्त भाव से मनुष्य की अपनी अवस्था के अनुरूप कर्त्तव्य पालन से परम पद की प्राप्ति होती है। साधना काल में साधन में ही मन प्राण अर्पण कर कार्य करो क्योंकि उसकी चरम अवस्था का नाम ही सिद्धि है। कर्म को उपासना के रूप में करने से परम पद व दिव्य ज्ञान की प्राप्ति होती है। अनासक्त पुरुष को सभी कर्त्तव्यों में आत्मा को मुक्त करने कर शक्ति दिखती प्रतीत होती है। कर्त्तव्य तो कर्त्तव्य ही होता है। अतः प्रत्येक कर्त्तव्य को सचेत होकर निभाना चाहिए। प्रत्येक कर्म को अपना कर्त्तव्य समझकर करने से आगे का रास्ता प्रशस्त हो जाता है।

स्वामी विवेकानन्द मानते थे कि हमारा कर्त्तव्य है कि दुर्बल के प्रति सहानुभूति रखें तथा अन्यायी के प्रति भी प्रेम रखें। मानव जितना अधिक शान्त होगा उसके द्वारा किये गये कार्य उतने ही श्रेष्ठ होंगे। यदि संसार में रहकर अर्थात् गृहस्थाश्रम में रहते हुए मोक्ष प्राप्ति करना है तो सदैव दूसरों के लिए संसार छोड़ने

को तैयार रहो। यदि सन्यासी बनकर मुक्ति प्राप्त करना है तो धन, यश, सौन्दर्य तथा अधिकार की ओर न देखो। विवेकानन्द कहते हैं कि आध्यात्मिक बल ही सर्वोत्कृष्ट है क्योंकि इसके द्वारा मानव को समस्त दुःख व क्लेश से छुटकारा मिलता है। समस्त दुःख व क्लेश का मुख्य कारण है सृष्टि में व्याप्त अज्ञानता।<sup>6</sup> इस अज्ञानता को बौद्धिक सहायता से दूर किया जा सकता है। अज्ञानता के दूर होने पर सम्पूर्ण सृष्टि ज्ञान से आलोकित हो जाती है और सम्पूर्ण मानव समुदाय में आध्यात्मिक ज्ञान जागृत होता है। सभी मनुष्यों के ज्ञानी होने पर और सभी ज्ञानियों में आध्यात्मिक बल का समावेश हो जाने से दुःख व क्लेश का स्वतः ही मानव के ऊपर प्रभाव नष्ट हो जाता है।

श्रीमद् भगवद्गीता में “मानव को कर्मरत रहने का उपदेश दिया गया है यह कर्म सत् व असत् दोनों का मिश्रित रूप है।<sup>7</sup> स्वामी विवेकानन्द का कहना है कि “जो शुभ कर्मों में भी अशुभ तथा अशुभ कर्मों में भी कुछ न कुछ देखते हैं वास्तव में वही कर्म का रहस्य समझते हैं।<sup>8</sup> कर्म चाहे सत् हों या असत् दोनों ही आत्मा के लिए बन्धन हैं। अतः समस्त कर्मों से मुक्ति प्राप्त करने पर ही मोक्ष की प्राप्ति होती है। जिस प्रकार पैर में कांटा लगने से दूसरे कांटे से उसे निकाला जाता है फिर दोनों को फेंक दिया जाता है और मनुष्य को संतुष्टि प्राप्त होती है उसी प्रकार शुभ एवं अशुभ जैसे बन्धनों को भी एक दूसरे के द्वारा हटाकर अर्थात् दोनों से छुटकारा प्राप्त करके ही मनुष्य को मोक्ष की प्राप्ति होती है।<sup>9</sup> कर्म सदैव करते रहो लेकिन निःस्वार्थ भाव से करो। निःस्वार्थ भाव से किया गया कर्म प्रेम पर आधारित होता है स्वामी विवेकानन्द मानते हैं कि चाहे जितनी ही आपत्तियां क्यों न उठानी पड़े परन्तु फिर भी कर्म करते रहो और कोई तर्क-वितर्क न करो। कर्म भी स्वयं के लिए न करके सदैव दूसरों के लिए करो। आत्म त्याग ही कर्मों का उद्देश्य है और यही कर्मयोग का लक्ष्य है।<sup>10</sup> प्रत्येक कर्तव्य और कर्तव्यनिष्ठा भगवद् पूजा का सर्वोत्कृष्ट रूप है। निष्कार्य कर्म और अनासक्त होकर कर्म करने से परम आनन्द और मोक्ष की प्राप्ति होती है।

निःस्वार्थ कर्म द्वारा मानव के चरम लक्ष्य मुक्ति की प्राप्ति ही कर्मयोग है।

समस्त नैतिक शिक्षाओं का लक्ष्य अनन्त विकास को प्राप्त करना है। नैतिकता और निःस्वार्थता के बाद ही मुक्ति प्राप्त होती है। अतः जो स्वार्थी हैं वे अनैतिक हैं और जो निःस्वार्थी हैं वे नैतिक हैं। कर्मयोगी का अपना कोई सिद्धान्त नहीं होता है बल्कि वह तो सदैव अपने लक्ष्य की प्राप्ति के लिए ही कार्यरत रहता है। वह प्रत्येक क्षण ईश्वर साक्षात्कार के लिए बेचैन रहता है। सच्चा कर्मयोग का त्याग नहीं बल्कि कर्म में त्याग का भाव रखता है। इसलिए विवेकानन्द जी कहते हैं कि “सृष्टि में रहकर कौशल से कर्म करते रहो और फिर बाहर निकल आओ यानी सृष्टि में रहकर अपने सभी कर्तव्यों को निभाओ फिर मुक्ति प्राप्त करो यही कर्मयोग है।<sup>11</sup> कर्मयोग के अनुसार मोक्ष प्राप्ति कर्म के द्वारा ही करना चाहिए।

संक्षेप में, स्वामी विवेकानन्द मानते थे कि वही व्यक्ति कर्मयोगी है जो निःस्वार्थ भावना से अनासक्त होकर सम्पूर्ण सृष्टि के कल्याण के लिए समस्त मानव जाति को प्रेरित करता है और स्वयं भी कर्म करता है। मुक्ति प्राप्त करने के लिए मानव को सृष्टि के बाहर जाना होगा अर्थात् समस्त बन्धनों से अनासक्त होना पड़ेगा क्योंकि संसार में आसक्त रहकर मुक्ति नहीं मिल सकती। समस्त बन्धनों से छुटकारा पाने पर ही मुक्ति संभव है। शास्त्रों के अनुसार दो ही उपाय ऐसे हैं जिनके द्वारा समस्त सांसारिक बन्धनों से मुक्ति मिल सकती है। पहला नेति-नेति अर्थात् निवृत्ति का मार्ग। यह मार्ग कठिन है क्योंकि सिर्फ इच्छा शक्ति सम्पन्न तथा उन्नत महापुरुषों के लिए ही साध्य है। दूसरा है इति-इति अर्थात् प्रवृत्ति का मार्ग। यह मार्ग सर्वाधिक प्रचलित है। इसमें सर्वस्व का त्याग करना पड़ता है। प्रत्येक कर्म को ईश्वर के प्रति समर्पित कर देना चाहिए। जीवन की जो इच्छा रखते हैं उन्हें मृत्यु की भी इच्छा रखनी पड़ती है। अतः मृत्यु से छुटकारा प्राप्त करने के लिए एकमात्र उपाय जीवन के प्रति आसक्त न होना है। श्रेष्ठ महापुरुष अपने कर्तव्य को शुद्ध, सात्विक तथा प्रेम से द्रवभूत

होकर करते हैं। कर्म के बाद कभी भी यश व धन की प्राप्ति की कामना नहीं करते बल्कि सबके कल्याण व मोक्ष प्राप्ति की कामना करते हैं और क्रियात्मक रूप से सबको लक्ष्य प्राप्ति के लिए प्रेरित भी करते हैं। “कर्मों के समस्त कर्मफलों को त्याग देने, दूसरों के प्रति भला करने से पूर्ण अनासक्त प्राप्ति होती है तभी मानव पूर्ण मुक्ति को प्राप्त करते हैं। यह मुक्ति ही कर्मयोग का आदर्श या चरम लक्ष्य है।”<sup>12</sup>

**ज्ञानयोग :-** कर्मयोग के तार्किक आधार को ज्ञानयोग कहते हैं।<sup>13</sup> इसमें ईश्वर एवं आत्मा का सम्मिलन है। स्वामी विवेकानन्द कहते हैं कि “ज्ञानयोग के द्वारा हम सभी के भीतर से प्रभु ही इस जगत में प्रकाशित हो रहा है अतः सृष्टि में व्याप्त सभी कुछ उस एकमात्र ईश्वर की ही अभिव्यक्तियाँ हैं।”<sup>14</sup> ज्ञानयोग ही एकमात्र ऐसा योग है जिसके द्वारा हमें सृष्टि की सभी वस्तुओं का ज्ञान प्राप्त होता है। ज्ञानयोगी सबके कल्याण की भावना रखते हैं। ज्ञान लाभ का एकमात्र उपाय एकाग्रता है। “ज्ञानी वही है जिन्होंने सत्य को प्रत्यक्ष कर लिया है और उसके साथ तादात्पय स्थापित कर लिया है अर्थात् एकरूप हो गये हैं।”<sup>15</sup> ज्ञानयोग को समझने के लिए निम्नांकित बिन्दुओं को समझना आवश्यक है—

**1. माया और मुक्ति :-** जन्म-मृत्यु की प्रक्रिया ही माया है। श्वेताश्वरोपनिषद में कहा गया है कि “मायां तु प्रकृतिं विधान्मायिनं तु महेश्वरम्” अर्थात् माया को ही प्रकृति समझो और मायी को महेश्वर जानो। आकर्षण सदैव माया के प्रति होता है। माया त्रिगुणात्मिका है। त्रिगुणमयी माया बड़ी मुश्किल से पार की जाती है और जो ईश्वर की शरण में आते हैं वे इस माया को पार कर जाते हैं। माया और प्रकृति दोनों एक ही प्रभु के दो रूप हैं। माया और प्रकृति मुक्ति प्राप्त करने के लिए मानव का आशा स्थल है। वेदान्त कहता है कि सम्पूर्ण सृष्टि के पीछे एक आत्मा है जो माया के अधीन नहीं है। सत्य की प्राप्ति कभी भी प्रकृति में नहीं हो सकती क्योंकि सत्य तो स्वयं ही हमारे अन्दर विद्यमान है। अतः मुक्ति और स्वतंत्रता दोनों ही मानव हृदय में विद्यमान है। वस्तुतः

आत्मा ही ब्रह्मस्वरूप है जो एक रस, पूर्णसत्य और सदा मुक्त है।

**2. ब्रह्म और जगत :-** ब्रह्म गतिहीन है वह कभी भी परिवर्तित नहीं होता परन्तु जगत परिवर्तनशील है क्योंकि वह देश काल निमित्त पर आधारित है। जहाँ ब्रह्म है वहाँ देश काल निमित्त नहीं हो सकता क्योंकि वहाँ न मन है और न विचार। ब्रह्म का अवनत रूप ही देश-काल निमित्त जगत है। जगत में ही सभी प्रकार के बाह्य और आन्तरिक विचारों का आदान-प्रदान होता है ब्रह्म में नहीं। स्वामी विवेकानन्द कहते हैं कि “मानव जन्म से ही अपने कार्यों को देश-काल निमित्त के अनुसार करता है और अन्त में ब्रह्म के दर्शन प्राप्त करता है।”<sup>16</sup> ईश्वर ज्ञात और अज्ञात से ऊँची अवस्था है वह मानव शरीर के हृदय में विद्यमान है परन्तु उसका कभी प्रत्यक्ष नहीं हो सकता। ब्रह्म और आत्मा एक है। स्वामी विवेकानन्द के अनुसार सम्पूर्ण सृष्टि में एक ही वस्तु का अस्तित्व है वह है ब्रह्म। “ज्ञानियों को चाहिए कि वे अज्ञानी कर्म में आसक्त व्यक्तियों में बुद्धि भेद न करें। विद्वान व्यक्ति को स्वयं मुक्त रहकर लोगों को सब प्रकार के कर्मों में नियुक्त करना चाहिए।

**3. अमरत्व :-** सृष्टि परिवर्तनशील है। यह परिवर्तन वृत्ताकार होता है। पहले वृक्ष से बीज बनता है और फिर बीज से वृक्ष बनता है। इसी प्रकार मानव का जन्म-मरण होता रहता है। इसी वृत्तरूप को क्रमविकासवाद का सिद्धान्त कहते हैं। आत्मा भौतिक शक्ति न होकर चैतन्य और अमर है। अमरत्व प्राप्ति की इच्छा रखने वाले ज्ञानी व्यक्ति विषयों से अपने की दूर कर अपनी अन्तरात्मा की ओर देखते हैं। स्वामी विवेकानन्द कहते हैं “जो व्यक्ति स्वयं में विश्वास रखता है वही अपने लक्ष्य को प्राप्त करता है।”<sup>18</sup>

**4. बहुत्व मे एकत्व :-** आत्मा अनन्त है। आत्मा की खोज अनन्त में ही होती है। आत्मा सदैव जागृत रहती है। आत्मा अमर है और शरीर हमेशा मृत्यु को प्राप्त होता है। आत्मा एक है परन्तु माया के कारण अनेक प्रतीत होती है। आत्मा पर ही संसार आश्रित है। इसी आत्मा



में ब्रह्म के दर्शन होते हैं। सत्यमार्ग का अनुसरण करने वाला ही एकत्व का दर्शन करता है। जिस प्रकार कड़ाही में तेल डालने से अनेक बुलबुले उठते हैं और अन्त में एकरूप हो जाते हैं उसी प्रकार सभी प्राणी एक ब्रह्म में अन्तर्भूत हो जाते हैं और बहुत्व में एकत्व स्थापित हो जाता है।

**5. वस्तुओं में ब्रह्मदर्शन :-** स्वामी विवेकानन्द सम्पूर्ण जगत की वस्तुओं में एक ही ब्रह्म के दर्शन करते थे। वे कहते हैं कि "मैं मस्तिष्कवान होने की अपेक्षा श्रेष्ठ हृदय होना चाहता हूँ जिससे सभी के भावों को जानकर उसके अनुरूप स्वयं को बनाकर सबके साथ सत्कर्म कर सकूँ।"<sup>19</sup> वे सभी वस्तुओं में ब्रह्म का दर्शन करना चाहते थे। वे कहते हैं कि यदि मानव सर्वत्र ईश्वर का आभास मात्र ही करे तो वह कभी भी अपने को दुःखी महसूस नहीं करेगा।<sup>20</sup> अज्ञानी व्यक्ति को प्रकृति में अनेक रूप देखता है जबकि ज्ञानी व्यक्ति को तो सर्वत्र ब्रह्म दर्शन ही दिखता है।

**6. आत्मा का मुक्त स्वाभाव :-** आत्मा का कोई आकार नहीं है वह मुक्त स्वाभाव है। विवेकानन्द कहते हैं कि "आत्मामुक्तस्वाभाव है। सत, चित और आनन्द आत्मा का ही स्वाभाव है। प्रकृति में आत्मा के विभिन्न रूप हैं।"<sup>21</sup> आत्मा के स्वाभाव को सत्य द्वारा जाना जा सकता है। विवेकानन्द जी कहते हैं कि "ज्ञान सूर्य की किरणें जितनी उज्ज्वल होने लगती हैं। मोह उतना ही दूर भागता है। अज्ञान राशि ध्वंस होती जाती है और अन्त में एक समय ऐसा आता है जब सारा अज्ञान लुप्त हो जाता है और केवल ज्ञानसूर्य ही शेष रह जाता है।"<sup>22</sup>

इस प्रकार स्वामी विवेकानन्द अपने दर्शन में ज्ञानयोग की महत्ता का वर्णन करते हुए ज्ञानयोग को श्रेष्ठ योग के रूप में प्रतिपादित करते हैं। वे मानते हैं कि एक सच्चा ज्ञानी वही है जिसकी सारी इन्द्रियाँ संयत हो जाती हैं। इन्द्रिया मन को चंचल नहीं कर पाती हैं तभी योगी को अपना लक्ष्य प्राप्त होता है।

**7. राजयोग :-** राजयोग के आठ अंग हैं इसलिए इसे अष्टांग योग भी कहते हैं। स्वामी विवेकानन्द के अनुसार

जब तक किसी बात का प्रत्यक्ष न कर लो, उस पर विश्वास न करो"<sup>23</sup> राजयोग के अनुसार योगी का मुख्य लक्ष्य अन्तर्दृष्टि का विकास करना है। राजयोग में योग के आठ अंग माने गये हैं –

**1. यम –** इससे सम्पूर्ण मानव शरीर नियंत्रित होता है। साधना के प्रारंभ में यम का पालन अति आवश्यक है। यम पाँच प्रकार से सम्पन्न हो सकता है।

(अ) अहिंसा – मन वचन और कर्म से हिंसा न करना अहिंसा है।

(ब) सत्य – मन वचन और कर्म से सत्य निष्ठ होना।

(स) अस्तेय – मन वचन और कर्म से लोभ न करना।

(द) अपरिग्रह – मन वचन और कर्म से व्यर्थ दान ग्रहण न करना।

(य) ब्रह्मचर्य – मन वचन और कर्म से पवित्रता रखना।

**2. नियम –** शौच, सन्तोष, तपस्या, स्वाध्याय और ईश्वर प्राणिधान अर्थात् ईश्वर के प्रति आत्मसमर्पण नियम हैं।

**3. आसन –** स्थिरता और सुखपूर्वक शरीर की स्थिति आसन कहलाता है।

**4. प्राणायाम –** कुम्भक, पूरक और रेचक द्वारा प्राणवायु को वशीभूत करने के लिए श्वास प्रश्वास का नियमन करना प्राणायाम है।

**5. प्रत्याहार –** मन को बाहरी विषयों से विमुख कर अन्तर्मुखी करना प्रत्याहार है।

**6. धारणा –** किसी एक विषय पर मन की एकाग्रता धारणा है।

**7. ध्यान –** किसी एक विषय पर मन का निरन्तर चिन्तन ध्यान है।

**8. समाधि –** ज्ञानातीत अवस्था अथवा ज्ञानलोक की प्राप्ति समाधि है।

स्वामी विवेकानन्द के अनुसार अन्य योगों की अपेक्षा राजयोग के लिए शारीरिक, मानसिक, नैतिक और आध्यात्मिक साधना की ज्यादा ही आवश्यकता होती है।

राजयोग के लिए अष्टांग योग के साथ-साथ प्राणों के आध्यात्मिक स्वरूप पर अधिक ध्यान देना चाहिए। राजयोग यथार्थ धर्मविज्ञान है। विवेकानन्द कहते हैं कि “राजयोग सारी उपासना, सारी प्रार्थना, विभिन्न प्रकार की उपासना पद्धति और समुदाय अलौकिक घटनाओं की युक्तियुक्त व्याख्या है।”<sup>24</sup>

**राजयोग के उद्देश्य** – योगाचार्य कहते हैं कि प्रत्येक धर्म पूर्वकालीन अनुभवों पर आधारित है। पूर्वकालीन अनुभवों के बगैर कोई भी धर्म नहीं टिक सकता। जिस विद्या के द्वारा ये अनुभूतियाँ होती हैं, उसे योग कहते हैं।<sup>25</sup> सत्य की प्राप्ति के लिए मनुष्य सदैव लगा रहता है, सत्य ही मनुष्य को ज्ञान से प्रकाशित करता है। राजयोग सत्य प्राप्त करने के लिए व्यवहारिक उपाय और साधनों का उपयोग वैज्ञानिक तरीके से करना बताता है। सत्य को प्राप्त करने के लिए मन पर नियंत्रण आवश्यक है। मन संयमित होने पर शरीर पर शीघ्र नियंत्रण हो जाता है। अतः ईश्वर प्राप्ति के लिए मन व शरीर को एकमुखी होना आवश्यक है।

राजयोग के अनुसार यह बहिर्जगत अन्तर्जगत का ही विकास रूप है। अन्तर्जगत को कारण और बहिर्जगत को कार्य समझा जाता है। स्वामी विवेकानन्द के अनुसार “अन्तर्जगत कारण और बहिर्जगत कार्यरूप है।”<sup>26</sup> राजयोगी को भोजन संतुलित, पवित्र तथा समयानुकूल करना चाहिए। भोजन का मन से विशेष संबंध है। कहा जाता है कि “जैसा खाये अन्न, वैसा होगा मन”। राजयोग श्रेष्ठतम योग है। इसलिए प्रत्येक साधक को राजयोग का निरन्तर अभ्यास करना चाहिए।

**भक्तियोग** – निष्कपट भाव से ईश्वर की खोज को भक्तियोग कहते हैं। स्वामी विवेकानन्द मानते हैं कि जब ईश्वर का आश्रय लिया जाता है उसकी शरण ग्रहण की जाती है एवं स्वयं को भगवान में लीन किया जाता है तब वह भक्तियोग की अवस्था है, भक्ति सूत्र में नारद जी ने कहा है कि “भगवान के प्रति उत्कट प्रेम ही भक्ति है।”<sup>27</sup> सांसारिक बन्धनों से विरक्ति के फलस्वरूप प्रेम का उदय होता है। भगवान की भक्ति के बाद सभी

मनुष्य उसके प्रेम पात्र हो जाते हैं। विष्णु पुराण में कहा गया है कि –

“मद्गुण श्रुतिमायेण मयि सर्वगुहाशये।

लक्षणं भक्ति योगस्य निर्गुसस्य हुदाहृतम्।।”<sup>28</sup>

अर्थात् गंगा प्रवाह की गति जिस प्रकार समुद्र की ओर अप्रतिरुद्ध और स्वाभाविक होती है। उसी प्रकार मेरे गुणों को सुन, मुझ सर्वव्यापक के मन की जो अविच्छिन्न गति होती है वही भक्तियोग का लक्षण है।

भक्तिमार्ग ज्ञान और कर्म दोनों से श्रेष्ठ है। “भक्ति स्वयं ही साध्य एवं साधनस्वरूप है।”<sup>29</sup> भक्ति योग ईश्वर प्राप्ति का सबसे सरल उपाय है। स्वामी विवेकानन्द का मत है कि “भक्तियोग मार्ग तो सरल परन्तु इसका द्वारा फल देर से प्राप्त होता है।”<sup>30</sup> भक्ति एक साधन है जिसमें हमें ईश्वर के दर्शन होते हैं। पराभक्ति ही ईश्वरीय अवस्था है। इस अवस्था में मनुष्य को सर्वत्र ईश्वर के दर्शन होते हैं। ईश्वर के प्रति आसक्ति ही भक्ति है। आध्यात्मिक अनुभूति के निमित्त किये जाने वाले मानसिक एवं शारीरिक प्रयत्न भक्ति है।

**भक्तियोग का ध्येय** – भक्तियोग का मुख्य ध्येय ईश्वर दर्शन है। ईश्वर के दर्शन के बाद मनुष्य को सर्वत्र ही ईश्वर का आनन्द का प्रकाश दिखाई देता है। भक्ति में वासनाओं का सम्पूर्ण त्याग करना होता है। स्वामी विवेकानन्द का कहना है कि वासना का मदिरा पान कर सम्पूर्ण जगत मस्त हुआ है। जैसे दिन और रात एक साथ नहीं रह सकते, वैसे ही वासना और भगवान एक साथ नहीं रह सकते। अतः ईश्वर प्राप्ति के लिए वासना का त्याग परमावश्यक है।<sup>31</sup>

भक्तियोग का लक्ष्य प्रत्यक्षानुभूति अर्थात् ईश्वर की प्रत्यक्ष अनुभूति है। प्रत्यक्ष अनुभूति के लिए मन की एकाग्रता आवश्यक है। एकाग्रता इच्छा शक्ति के दौरान सम्पन्न होती है और इच्छा शक्ति विचार शक्ति एवं प्राणायाम के द्वारा वशीभूत होती है। अतः एकाग्र मन ही ईश्वर प्राप्ति का श्रेष्ठ साधन है।

**भक्ति के साधन** – रामानुजाचार्य का मत है कि भक्ति की प्राप्ति विवेक, विमोक, अभ्यास, क्रिया, कल्याण, अनवसाद और अनुद्वर्ष से होती है।

(1) **विवेक** – विवेक का अभिप्राय सोच विचार कर आहार करना है। आहार सात्विक हो।

(2) **विमोक** – विमोक का अर्थ इन्द्रियो को विषयों की ओर रोकता है। यही साधना की नींव है।

(3) **अभ्यास** – आत्मसंयम का अभ्यास करना चाहिए।

(4) **क्रिया** – क्रिया यज्ञ की अवस्था है। पंच महाभूतों को नियमित रूप से अनुष्ठान करना ही क्रिया है।

(5) **कल्याण** – कल्याण का अभिप्राय-आन्तरिक एवं बाह्य पवित्रता है। रामानुज के अनुसार “सत्य, सरलता, दया, अहिंसा, परद्रव्यलोभ, वृथाचिन्तन और अनिष्ट आचरण का चिन्तन का त्याग ही कल्याण है।”<sup>32</sup>

(6) **अनवसाद** – अनवसाद का अर्थ बल है। बलहीन व्यक्ति साधना नहीं कर सकता है।

(7) **अनुद्वर्ष** – मन की शान्त अवस्था ही अनुद्वर्ष है इससे आध्यात्मिक अनुभूति होती है।

**भक्त का वैराग्य** – भक्तियोग उच्चतर प्रेम का विज्ञान है। प्रकृति में सर्वत्र प्रेम का रूप विद्यमान है चाहे वह विनाश के रूप में हो चाहे हर्षोल्लास के रूप में। प्रकृति के कण-कण में ईश्वर का प्रकाश प्रकाशित है। भक्त को संसार से वैराग्य होना चाहिए और सर्वत्र ईश्वर का दर्शन करना चाहिए।

**भक्ति के अवस्था भेद** – शांडिल्य सूत्र के अनुसार भक्ति तीन प्रकार की होती है।

(1) **श्रद्धा** – श्रद्धा का वास्तविक अर्थ प्रेम है। जहाँ प्रेम विद्यमान नहीं नहीं है वहाँ श्रद्धा नहीं होती है। प्रेम के साथ श्रद्धा उत्पन्न होती है। प्रिय वस्तु की प्राप्ति ही

हमारी श्रद्धा रखती है जैसे शिष्य गुरु के प्रति एवं भक्त ईश्वर के प्रति श्रद्धा रखता है।

(2) **प्रीति** – प्रीति का अर्थ ईश्वरीय चिन्तन में आनन्द की प्राप्ति। सांसारिक दृष्टि से इन्द्रिय विषयों में आसक्त होना प्रीति है परन्तु आध्यात्मिक दृष्टि से भक्त का ईश्वर के प्रति चिन्तन ही प्रीति है।

(3) **विरह** – प्रेमी के अभाव में उत्पन्न होने वाला प्रेम विरह की अवस्था है। यह अवस्था बहुत ही मधुर है। भगवान श्रीकृष्ण के प्रति राधा का विरह जगजाहिर है। भक्त मुक्ति नहीं चाहता है। वह सदा सर्वदा ईश्वर का दर्शन चाहता है। प्रेम, प्रेमी और प्रेमास्पद तीनों ही भक्ति के रूप हैं।

स्वामी विवेकानन्द में एक भक्तियोगी के समस्त लक्षण उपस्थित थे, भक्ति की प्रथम सीढ़ी प्रेम है। प्रेम के द्वारा संसार पर विजय पायी जा सकती है और ईश्वर को भी। स्वामी विवेकानन्द ने कर्म योग, ज्ञानयोग, राजयोग और भक्तियोग की व्याख्या मानव स्वभाव की भिन्ता के आधार पर की है। समस्त योग विधियों का लक्ष्य ईश्वर-साक्षात्कार करना है।

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