RESEARCH PAPER:

Geochemistry of coal washery effluents in Zarand region, Kerman province, South-east of Iran

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SUMMARY

The present study deals with the water pollution produced by coal washery effluents accumulated in tailing tank, Zarand region, Kerman province, Southeast of Iran. Sampling has been done from waters discharged to the tailing tank. Water/effluent samples were analysed for measurement of parameters namely, colour, total suspended solids (TSS); chemical oxygen demand (COD); total dissolved solids (TDS), acidity or alkanity (pH), temperature, oil and grease and heavy metal contaminants. The coal processing results essentially in production of huge quantities of suspended material, which is beyond the stipulated limit of 100 mg/l as specified in the standard. Formation of a thin film of oil and grease on the water discharged from coal washing plant, oil and grease, turbidity (NTU), TSS, COD and TDS were increased in water discharged to the tailing tank. The concentration of Mg was exceeding the permissible limit. Heavy metals such as copper, nickel, zinc, lead, chromium, cadmium, arsenic, mercury and iron were very less in the effluents indicating that coal washing processing was not effective on increasing heavy metals.

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Key words : Coal washery, Tailing tank, Effluents, Heavy metals

Coal, a fossil fuel, is the largest source of energy for the generation of electricity worldwide. Coal is inherently a "dirty" source of energy. Row coal contains non-coal minerals that will be released as polluting discharge during washing. Coal washeries have been implicated as one of the major sources of surface and groundwater pollution (Gurdeep Singh, 1986, Bandopadhyay, 1987; Gupta and Singh, 1995).

One of the main objectives of coal preparation is to reduce the quantity of pollutants in coal that is burnt. Washing principle of coal is mainly based on the different in specific gravity between coal and its impurities, the difference processing techniques depend on the washibility characteristics of particular coal. Preparation of coal by physico-chemical methods is known washing/beneficiation. Extracted coal from Pabedana coal mine is transported by trucks to Zarand, coal washing plant, which is 65 km south of Pabedana coal mine (Fig. 1). At Zarand coal processing was commenced in 1978 with a capacity of 2 million tons of raw coal with 61% production efficiency. Zarand coal washing plant is one of the biggests processing plants in southwest of Asia.

The effluents from coal washing processes contain large amounts of suspended and dissolved solids, dirty materials and impuries associated with raw coal and they create serious problems of deterioration of water quality of groundwater into which they are discharged (Ghose, 1999). Effluent from coal mine contains high load of TDS, calcium, carbonate and heavy metals hence contaminates the aquatic regime (Dhar *et al.,* 1986). Heavy metals are one of the most detrimental fractions of mining effluent, being persistent accumulates in water, soil, sediment and living organisms (Miretzky *et al.,* 2004). The present study has been carried out on the geochemical characterization of washery effluents from coal washery which accumulated in tailing pond. Finally, assessment of pollution was conducted by coal washery in surrounding area.

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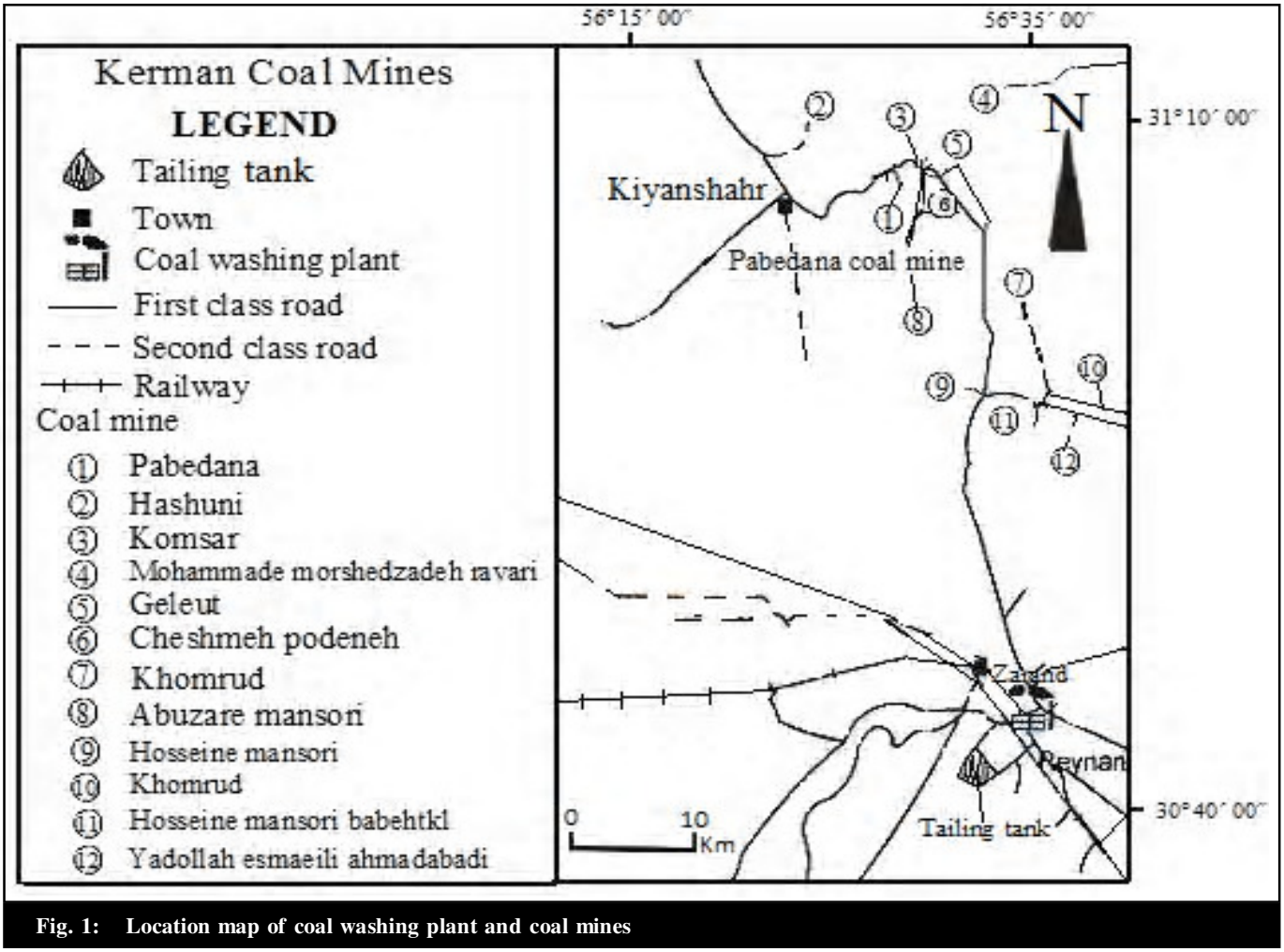


Fig. 1: Location map of coal washing plant and coal mines

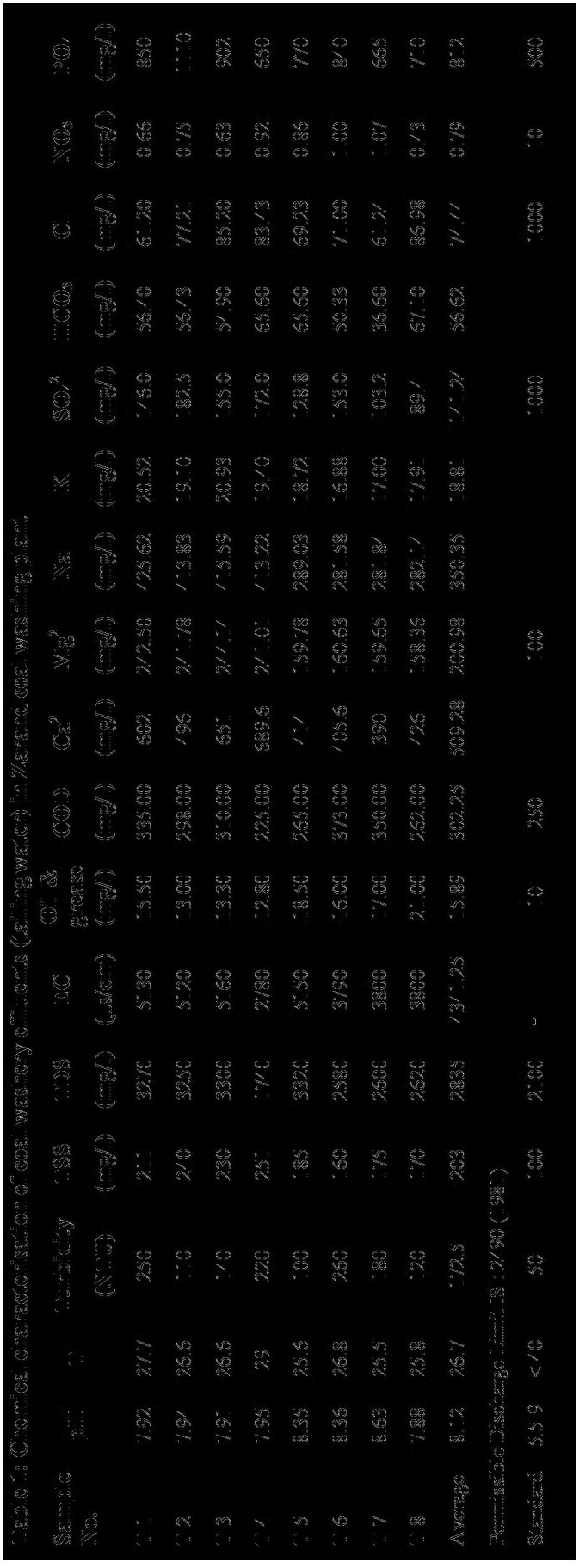
MATERIALS AND METHODS

Water tailings or water effluent samples were collected from the Zarand coal washing plant during Aug-Sep 2009 to study geochemistry of water tailing. Water samples were collected from 8 points tailing tank. Water samples were stored in new 1000ml polyethylene-bottles, which were pre-washed first with deionized water subsequently the deionized water for 24 h, emptied, and dried in air before the water samples were collected. In addition, the bottles were rinsed three times with the water being collected at each site. The bottles were completely filled and capped tightly to avoid contamination from atmospheric CO_2^- during the collection of the water samples from tailing, care was taken to avoid contaminating the sediment suspended in the water with streambed sediment. The pH and EC were measured at each site by dipping it directly into the stream. Water samples were transported to the laboratory and stored in refrigeration. The water samples were filtered through 0.45 µm Supor-450 Membrane filters. Finally, the filtered water was acidified to pH < 2 with trace-metal-grade HNO_{3-} and stored in a dark room until it was analysed.

Parameters were outlined in Iran environment protection organization and Zarazma company in Tehran, Iran. They measured elements namely, sodium, potassium, calcium, magnesium, manganese, copper, nickel, zinc, lead, chromium, cadmium, arsenic, mercury and iron and were determined in water/washery effluent samples to assess the potential pollutants being transferred from the coal being washed to the effluent. Water/effluent samples were analysed for parameters namely, colour, total suspended solids (TSS); chemical oxygen demand (COD); total dissolved solids (TDS), acidity or alkanity (pH), temperature, oil and grease and heavy metal contaminants. The results of water tailing are presented in Tables 1 and 2.

RESULTS AND DISCUSSION

Discharge of coal washery effluents gives rise to the serious problem of visual and aesthetic pollution.



Characterisation of tailing waters is presented in Table 1. The appearance of these waters during discharge from the outlet of washery premises was, in general, of brownish-black in colour coupled.

Turbidity (NTU):

Turbidity is a measure of the degree to which the water loses, its transparency due to the presence of suspended particulates. The more total suspended solids in the water, the murkier it seems and the higher the turbidity. The suspended particles absorb heat from the sunlight, making turbid waters warmer, and so reducing the concentration of oxygen in the water. Turbidity Units (NTU) are needed for proper ecosystem functioning. The suspended particles also help the attachment of heavy metals and many other toxic organic compounds and pesticides. Turbidity appearance varied from 100 to 260 NTU which was very high and exceeded of 50 NTU permissible discharge limit IS: 2490 (1981) (Table 1).

Total Suspended Solids (TSS):

Total suspended solids is a water quality measurement usually abbreviated as TSS. It is listed as a conventional pollutant in the U.S. Clean Water Act. TSS is solid materials, including organic and inorganic, that are suspended in the water. These would include silt, plankton and industrial wastes. High concentrations of suspended solids can lower water quality by absorbing light. The concentration of TSS was found in the range of 160-251 mg/l which was higher than the permissible limit of 100 mg/l as per IS: 2490. This reflects practically non-functional of clarification system with hardly any recover of coal fines/suspended solids. It was observed that, during this investigation in Zarand coal washing plant, proper recovery system was not working well and there was over flow from the setting pond provided for the contaminant of suspended solids/coal fines. Besides, this gave rise to enormous economic loss due to escaping of coal fines through the discharge of effluents, in general, settling of suspended solids. Beside the coal washing plants are situated in very close proximity of Zarand city and agricultural land, there has been continued and uncontrolled discharge of effluents from coal washing into the groundwater. There was a problem of land availability and as such proper time for natural settling of suspended solids/coal fines was not provided. The problem intensified due to non-provision of application of coagulants/ flocculants for clarification of effluents with proper coal fines recovery system.

Table 2: Heavy metals chemistry of coal washery effluents (tailings water) in Zarand coal washing plant

Sample No.	Fe (mg/l)	Cr (mg/l)	Cu (mg/l)	Mn (mg/l)	Pb (mg/l)	Zn (mg/l)	Cd (mg/l)	Hg (mg/l)	As (mg/l)
T-1	1.136	0.009	0.023	0.623	0.017	0.474	0.001	BDL	0.01
T-2	0.425	0.008	0.011	0.55	0.006	0.03	BDL	BDL	0.005
T-3	0.735	0.008	0.014	0.602	0.005	0.03	0.0008	BDL	BDL
T-4	0.481	0.008	0.017	0.528	0.007	0.041	BDL	BDL	BDL
T-5	0.281	0.0067	0.009	0.444	0.0022	0.022	0.0007	0.0003	0.004
T-6	0.426	0.0067	0.0084	0.485	0.0018	0.02	0.0006	0.0002	0.004
T-7	0.148	0.0066	0.0088	0.425	0.0013	0.011	0.0008	0.0003	0.003
T-8	0.125	0.0064	0.0083	0.38	0.0013	0.012	0.0007	0.0003	0.003
Average	0.470	0.007	0.012	0.505	0.005	0.080	0.0007	0.0003	0.004
Permissible Discharge Limit IS : 2490 (1981)									
Standard	3	2	3	2	0.1	15	2	0.01	0.2

Chemical Oxygen Demand (COD):

Chemical Oxygen Demand (COD) is defined as the quantity of a specified oxidant that reacts with a sample under controlled conditions. The quantity of oxidant consumed is expressed in terms of its oxygen equivalence. COD is often used as a measurement of pollutants in natural and waste waters and to assess the strength of waste such as sewage and industrial effluent waters. In present study, the COD levels in washery effluent samples were found to be from 225 to 373 mg/l. Hence, the COD level in general, except of T_4 sample exceeded the permissible limit of 250 mg/l, which was mainly due to the reducing nature of coal fines and other suspended solids in the tailing water.

Oil and grease:

The concentration of dispersed oil and grease is an important parameter for water quality and safety. Oil and grease in water can cause surface films and shoreline deposits leading to environmental degradation, and can induce human health risks when discharged in surface or ground waters. In present study, another water pollution problem identified was due to discharge of oil and grease content in significant quantities in the tailings. Oil and grease content was observed from 12.8 to 21 mg/l and it was generally exceeded the permissible limit of 10 mg/l. Oil and grease may interfere with aerobic and anaerobic biological processes and lead to decreased wastewater treatment efficiency.

Heavy metals:

Heavy metals are a major concern in the treatment of water due to the toxic and other detrimental effects which these materials can produce. In the study area, heavy metals namely, the concentration of Fe varied from 0.125 to 1.136 mg/l with an average of 0.47mg/l. The Cr content varied from 0.0064 to 0.009 mg/l with an average of 0.007 mg/l. The values of Cu ranged from 0.0083 to 0.023 mg/l with an average of 0.012 mg/l. The concentration of Mn varied from 0.38 to 0.623 mg/l with an average of 0.505 mg/l. The Zn content varied from 0.011 to 0.474 mg/l with an average of 0.080 mg/l. The concentration of Pb varied from 0.0013 to 0.017 mg/l with an average of 0.005 mg/l. The values of Cd range from below detection limit (BDL) to 0.001 mg/l with an average of 0.0007 mg/l. The concentration of Hg varied from below detection limit (BDL) to 0.003 mg/l with an average of 0.0003 mg/l. The concentration of As varied from below detection limit (BDL) to 0.01 mg/l with an average of 0.004 mg/l. These heavy metals were observed at significant concentration levels but were below the permissible limits as per IS: 2490 and as such do not seem to pose any serious pollution problem (Table 2).

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REFERENCES

Bandopadhyay, P. (1987). Emission of water pollutants from coal washeries and water pollution control technology, Seminar on Water pollution and land reclamation in mining areas with special refrence to Jharia coalfield, ISM, Dhanbad. June 5, 1987.

Dhar, B.B., Ratan, S., Jamal, A. (1986). Impact of opencast coal mining on water environment: A case study, *J. Mines, Metals Fules*, **34**: 596-601.

Ghose, M.K. (1999). Sustainable supplies of water for coal washeries in India. *Science Total Environment*, **22(**9): 217-225.

Gupta, Ravi and Singh, Gurdeep (1995). Water pollution profile of coal washeries, *Poll. Research* , **14**(2): 203-213.

IS. (1981). Indian Standards for industrial effluent. IS: 2490.

Miretzky, P., Saralegui, A. and Fernandez Cirelli, A. (2004). Aquatic macrophytes potential for the simultaneous removal of heavy metals (Buenos Aires, Argentina). *Chemosphere*, **57**: 997-1005.

Singh, Gurdeep (1986). Status of water quality in a mining area: A case study of Jharia coalfield. Internat. Symposium on Environmental Management, Istanbul Turkey, June 5-9, 1986.