

# **WATER QUALITY ANALYSIS IN COAL WASHERIES**

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE  
REQUIREMENTS FOR THE DEGREE OF

**BACHELOR OF TECHNOLOGY**

**IN**

**MINING ENGINEERING**

BY

**Kolli Hareesh**

111MN0520



**DEPARTMENT OF MINING ENGINEERING**

**NATIONAL INSTITUTE OF TECHNOLOGY**

**ROURKELA - 769008**

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UNDER THE GUIDANCE OF

**PROF.D.P.TRIPATHY**



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**NATIONAL INSTITUTE OF TECHNOLOGY**

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**NATIONAL INSTITUTE OF TECHNOLOGY**

**ROURKELA**

*CERTIFICATE*

This is to certify that the thesis entitled “**Water Quality Analysis in Coal Washeries**” submitted by **Kolli Hareesh** in partial fulfillment of the requirements for the award of Bachelor of Technology degree in Mining Engineering at National Institute of Technology, Rourkela (Deemed University) is an authentic work carried out by him under my supervision and guidance.

To the best of my knowledge, the matter embodied in the thesis has not been submitted to any other University/Institute for the award of any Degree or Diploma.

**Date:**

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## **ACKNOWLEDGEMENT**

I wish to express my profound gratitude and indebtedness to **Prof. D. P. Tripathy**, Professor, Department of Mining Engineering, NIT, Rourkela for introducing the present topic and for his inspiring guidance, constructive criticism and valuable suggestion throughout this project work.

Also I would like to extend my gratitude to all our friends who have patiently extended all sorts of help for accomplishing this undertaking.

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## **ABSTRACT**

Water is the most important element of eco-system and it is thus imperative to determine and mitigate the effects of mining operation on the same. Also, contaminated water has adverse physiological effects on human being and other animals. For this, it is important to identify the critical parameters in the water sample which is the scope of the study.

Therefore an attempt made to analyze the characteristics of the effluent that comes from the three coking coal washeries of Central Coal fields Limited in certain Kedla Coal washery, Rajrappa Coal washery and Kargali Coal washery in Jharkhand state, India. For this study, raw water or the intake water to the washery, fine coal jig water, coarse coal jig water and slurry lake water were collected from the three washeries. Parameters illustrated in Ministry of Environment and Forest (MoEF) Schedule VI Indian principles (2006) were determined along with the sodium, potassium, magnesium, manganese, calcium in the washery effluent samples. The pH is observed to be decreased in the process water. The concentrations of major elements in coal—Na, K, Ca and Mg were found to be higher in process water than in raw water indicating that these elements are transferred from coal to the water in washeries. However, only in the case of Mn, the stipulated limit of the effluent standard was exceeded. Trace elements like As, Se, Cd, though found to be present in coal, were absent in the process water indicating that these elements are not released by coal during washing.

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# **Chapter-1**

## **INTRODUCTION**

# 1. INTRODUCTION

The primary coal washery in India was introduced in the year 1951 by Tata Steel, at west Bokaro, Jharkhand. From that point forward various washeries have come up fundamentally for coking coal. Instantly 37 washeries are under operation in the nation. Out of these, 20 are coking coal washeries and the remaining 17 are non-coking coal washeries. Water is the most well-known medium for transporting material in beneficiation plants and consequently most coal detachments happen inside this medium. Maybe the best and the most long-standing issue in coal beneficiation plants is the transfer of gushing, which contains a suspension of fine solids.

## 1.1 Coal Washeries

Coal beneficiation is a physical process wherein the raw coal is crushed in crusher, screened and separated through wet gravitation process in Batac jig. The rejects generated from the beneficiation is part of the coal which contains more ash hence not used for metallurgical process. The rejects consists of carbonaceous shale and coal which has less carbon percentage. Rejects are collected in reject bunker in the Washery from where it is dispatched to dump area. The Washery is also sells rejects in the open marked to minimize the reject disposal problem. Installation of captive thermal power plant of MW capacity can be installed which utilizes for power generation.

The physical and chemical analysis shows that ash constitutes a major portion of rejects and on an average it above 55%. Ash is mainly refractory material and constitutes mainly carbonaceous shale and silica. The chemical composition of the rejects is such that leachate would not form heavy concentration of organic or inorganic pollutants.

Tailings from the process are collected in tailing ponds. Tailings (fine sludge) are being recovered from tailing pond which is being mixed with rejects and disposed off.

The washeries are working on a closed circuit system and subsequently the effluent created from the coal washeries containing suspended solids is pumped to settling lakes in which every single fine strong progressively settle and the sensibly clean water is reused.

However the information accessible to date are inadequate to characterize the piece and amounts of gushing as a component of coal sort or coal cleaning procedure varieties. The methodology

water and waste qualities of coal beneficiation plants rely on the specific procedure or recuperation method utilized and the coal handled.

The run-of-mine coal is pulverized down to littler sizes in these washeries for simple taking care of furthermore to free coal particles caught in extensive shale particles for development in quality and amount of clean coal.

The various equipment used in the washeries are

- 1 Jigs
- 2 Heavy media cyclone
- 3 Froath flotation

Thickeners are utilized for dewatering. Jigs are in view of the guideline of gravity partition overwhelming media typhoons utilize diffusive activity yet despite the fact that dealing with the rule of gravity focus, it is not quite the same as jiggling. Dances depend on stratification in a bed of coal when the conveying water is beat. The coal is stratified by foaming air straightforwardly through the coal-water reject mixture in this cleaning unit. In a tornado food is as mash comprising of magnetite and coal slurry is presented underweight, which utilizes floatation operators, for example, pine oil and diesel oil for beneficiation of better estimated coal(-0.5mm) and is the most broadly acknowledged innovation for treatment of ultra-fines. The traditional spiral thickener is contained a roundabout tank, into which a component comprising of a drive head, shaft or confine and pivoting arms is fitted. The pivoting arms fill the double need of passing on sedimented solids to a main issue of release impact subsequently packing the silt and discharging water, in this way making a thick yet sensible sub-current slurry. The notable highlights of both coking and non-coking washeries vary.

The tailings that are produced in the form of slurry are not allowed to be directly discharged outside as per the Regulations of Indian Government

The effluent that is generated can contain the parameters that are entitled in the Ministry of Environment and Forest (MoEF) Schedule VI Indian Standards [Central Pollution Control Board (CPCB), 2001] namely manganese, nickel, copper, zinc, lead, cadmium, chromium, arsenic,

selenium and iron are to be estimated in water effluent samples to assess the potential pollutants being transferred from the coal.

## **1.2 OBJECTIVES OF THE STUDY**

Having mentioned the importance of assessing water quality, the work has been planned with the following objectives:

- Analysis of the water samples of washeries for water quality parameters and
- Identification of the pollutants which are not desirable in water vis-à-vis water quality standards and take remedial measures

## **Chapter-2**

# **LITERATURE REVIEW**

# 1. LITERATURE REVIEW

There's no doubt that coal often contains a range of pollutants including uranium, thorium, arsenic, mercury and other elements that are toxic at low concentrations. However these methods of mining generates large amounts of waste which may decrease the water quality. The real effects of mining courses of action is the sullyng of water bodies through mine water seepage, spillage of water presented to minerals, water from soil stacks. Water is the most imperative component of eco-system and it is accordingly basic to focus and moderate the impacts of mining operation on the same. Likewise, tainted water has unfriendly physiological impacts on human and different creatures.

## 2.1 Scholarly work of different researches

The accompanying is a brief audit of work of different scientists on water quality studies because of mining:

**Singh** (1997) did various investigations and concluded that the real effects of mining are water contamination because of disintegration, oil, tainting of water bodies because of release of mine water effluents, leachates from wash-off dumps, strong waste transfer locales, broken rocks, harmful squanders, saltiness from mine flames, corrosive mine seepage and so on. He recorded the real moderation routines as takes after: Overburden run-off gathering and treatment with resulting control, Oil separators, Collection/stockpiling of leachates, drainages, wash-offs with ensuing treatment, Proper sanitation and procurement of residential and sewage effluents treatment, Treatment of mine water releases.

He recommended that as there is intense deficiency of water supply in mining ranges, growth of underground pumped out mine water for different supplies can be given. This is monetarily financially savvy and gives reserve funds towards water and vitality preservation while giving natural and social advantages.

**Cherry et al** (1999) completed an integrative evaluation of water sheds affected by mines in south-western Virginia, USA and Ely Creek, a tributary toward the North Fork of the Powell

River was chosen. The reason for the study was to explore the helpfulness of integrative bio-evaluations, which utilize a few unique sorts of evaluation devices to get a wide, general photo of the ecological effects of poisons in a given zone. The parameters utilized as a part of the study incorporated: (1) water segment science; (2) residue metal science; (3) perpetual silt danger to a cladoceran (*Daphnia magna*) and midge; (4) intense water section poisonous quality to another cladoceran; (5) unending in situ lethality testing with Asian mollusks; (6) in situ benthic full scale invertebrate examining; and (7) living space evaluation and eco-toxicological rating (ETR) is dead set. They found that when pH was reliably at or beneath 3.0, in situ benthic full scale organic entities are not very many. What's more, at Acid mine waste (AMD) locales where pH extended from 3.5 to 6.0, a few endpoints were inhumane to natural anxiety. Their study demonstrated that the abiotic inspecting strategies, (water science, living space appraisal and metals examination) showed the degree of ecological anxiety.

**Jarvis and Younger** (2000) discovered that the effect of metal components releases from mines and ruin loads on accepting streams is adverse. Oceanic greenery are profoundly bankrupted. Their study plots the strategies for mine water sway evaluation utilized as a part of the UK. Their technique is to measure mine water affects by selecting/organizing components as per their impact. This was finished by measuring existing effects by means of synthetic, natural, and visual clarification. The other methods include the following:

1. Method by the national rivers authority:
  - a. Physicochemical assessment of watercourse
  - b. Use of Benthic macro-invertebrates for second phase of assessment,
2. Chemical and ecological studies

Their study showed that the above were not adequate for evaluating the impact of underground mining. The utilization of cutting edge hydro-geographical and geochemical demonstrating systems is obligatory. They proposed that for any EIA a portion of the elements that are to be considered are: Local learning that can give a significant knowledge into the beginnings of mine water contamination and accurately taught neighborhood group individuals.

In the experience of the creators, a joint effort of expert architects and neighborhood group is an appealing recommendation to potential subsidizing bodies. Likewise nearby groups can help with development of remediation plans, and maybe all the more essentially can guarantee normal support of such offices.

**Roy et al.** (2003) in the wake of completing various tests discovered that mining influences colossal zone of the area and influence the nature of surface and underground water by including contaminants and harmful mixes making it hazardous for drinking and mechanical use, aggravating the hydrology of the region. They found that the significant wellsprings of fluid effluents were: surface run-off, mine water pumped put amid seepage operation, spent water from taking care of plants, dust extractors and dust concealment frameworks, effluents from readiness and beneficiation plants, and drains/wash-off from waste/tailing dumps.

Additionally, as per their exploration Acid mine seepage is delivered at whatever point in a mine of any sort penetrable arrangements interfaces with the water table, aquifer, or roosted water body, or where surface water thinks that some way or another into a mine where sulfides (especially pyrites) are show in the mineral or nation rock. Amongst shocking highlights of the corrosive mine seepage are low pH and elevated amounts of sulfates, iron, and aggregate broke up solids.

These drain oxygen level in water, build danger by rendering substantial metals solvent, and make erosion issues. Corrosive mine waste can be viably controlled by keeping its development at source, by weakening the corrosive mine seepage to adequate rich quality, and by utilizing standard waste water treatment techniques for balance and evacuation of disintegrated solids.

Notwithstanding the corrosive mine waste, they guarantee another wellspring of water contamination to be the convey off of the fine strong particles from the surface mining locales and coal planning plants, particularly amid stormy seasons, into the streams and water-courses. Once in a while the overburden is dumped along the banks of the streams and water-courses, bringing about blockage of free stream and sullyng of water. It has additionally created an extreme harm to the products flooded by the stream water downstream.

Plant spillage, truck haulage, transport exchange focuses, and rail wagon stacking territories, are normal sources contributing fines best the surface run-offs. Relinquished factory tailings, coal decline piles, ruin stacks, and other waste dumps in mining territory contain huge measures of broke down minerals, are ceaseless wellsprings of stream contamination, aside from displaying blemish sights. Digging is additionally in charge of changing the hydrology of a territory from numerous points of view. Subsidence because of underground mining influences underground water, interruption of surface seepage examples and coming about commitment to stream contamination. Infrequently it may change the stream course and release, there by influencing the horticulture and verdure of the territory.

**Lambert** (2004) observed that in a few ranges of the Appalachian coal fields and in coal mining areas of the UK, mine water sharpness and iron burden are most serious in the first years after a release starts, however diminishes relentlessly and significantly with time. Their study was to record the degree of water-quality changes in the Uniontown Syncline AMD releases, and to explore geochemical and pressure driven elements in charge of the progressions. While in operation, the benefit of these mines was the way that water did not pool and impede mining exercises, yet rather went down incline and out of the mine. The release from Uniontown Syncline Pittsburgh Coal crease stream into two noteworthy streams, or their tributaries: the Youghiogheny River in the north piece of the Syncline, and Redstone Creek in the south part. Anyhow, the strategy took after for this study included: Sample accumulation from 21 locales and field estimations of pH, temperature, broke up oxygen, conductivity, ferrous iron and stream. Results were recorded and contrasted and results from Scarlift study (1974). Hence Long-term changes in the nature of surrendered underground coal mine releases were considered. The study displayed clear confirmation for common change of the nature of seepage for deserted mine releases. They proposed that the sort and size of water-quality changes that happened after some time, predominantly relies on upon the level of flooding inside the mine voids adding to the releases, and the time slipped by since mine relinquishment. In overwhelmed mines of the Uniontown Syncline, acidic releases have gotten to be antacid in under 25 years. In the releases from un-overflowed mines, M59 and others north of the Youghiogheny River, upgrades in water quality have additionally happened more than 25 years, however to a littler degree than watched

for the overwhelmed mines. Consequently their study demonstrated that the accessibility of oxygen for AMD generation is identified with the degree of flooding in the mine voids.

**Heyden and New (2005)** done various analyses and watched that the utilization of wetlands to treat mine effluent has developed in fame in the course of recent decades, despite the fact that the methods by which the common frameworks capacity are regularly inadequately caught on. This field-scale examination uses day by day information over a 9-month period in evaluating the courses of action prompting the remediation of mine emanating inside a characteristic wetland on the Zambian Copper belt. The study separates emanating remediation through weakening from poison maintenance. Diminished wetland outpouring convergences of SO<sub>4</sub> and Na are because of weakening just, while Co (50%) and particularly Cu (83%) are held inside the wetland. Maintenance was connected to adsorption onto new or prepared surfaces amid a beginning time of gushing discharge into the framework and to courses of action identified with pH buffering to 7.5. The wetland's corrosive buffering limit was generally the aftereffect of carbonate-rich groundwater release into the wetland. In spite of the fact that this buffering limit likely shows minimal regular vacillation (20–80 k mole/day), the effect of acidic effluent enter on the wetland itself presumably changes notably between seasons, inferable from the fleeting and spatial qualities of release from the catchments aquifers. Evaluation of other characteristic wetlands in the district demonstrated that some (around 15%) indicated comparable catchment size, hydro chemical and hydrogeological qualities as those of the New Dam wetland, likely exhibiting a comparative effluent remediation potential as that portrayed here.

**Roy Choudhury and Starke (2006)** appreciated and surveyed the potential risk of metal contamination from dewatering of Grootvlei Gold Mine emanating into the Blesbokspruit, a Ramsar confirmed wetland site, the Witwatersrand rock of this region contains sulfide minerals, similar to pyrite pyrrhotite, chalcopyrite, gersdorffite, arsenopyrite, galena cobaltite, Fe, Ni, Pb, Cu, Co, As and U-bearing leachable oxides (Scott). Groundwater leaks through the mineral reef, consequently, has high Fe, SO<sub>4</sub> and follow metal substance. Emanating pumping accordingly brought about transfer and dispersal of follow metals in the surface water framework. Blesbokspruit stream energizes the neighborhood dolomite aquifer. The poor water quality consequently is prone to effect the freshwater assets in the range like Vaal River. The evaluation

was done by Surface water and silt inspecting, determination of Water science by pH, electrical conductivity (EC), broke down O<sub>2</sub> (DO), redox potential (Eh), temperature, particle Chromatograph (DX500) and nuclear ingestion spectra-photometry test, which was trailed by Leachate test utilizing ICP-MS., CHN analyzer to focus the natural C in the dregs. They additionally surveyed the Sediment quality by deciding Enrichment variable (Ef), Geo-accumulation file, Metal contamination record (MPI) and Sediment quality rule list (SQG-I). For follow component examination bunch investigation is performed. Bunch examination was further used to recognize the aggregate versatility conduct of follow metals in Blesbokspruit

It was observed that the impact of mine water releases is nearly a littler source on the grounds that (1) the pH of the water is commonly high from moving through the nearby dolomite aquifer, and (2) the mine water experiences high thickness partition took after by lime treatment before it is released. Both of these elements advance precipitation of metals instead of scattering and hence the portability of follow metals is moderately low in the examined region. Additionally the segment coefficient for the majority of the deliberate follow metals in Blesbokspruit is discovered to be high, which prompts their collection in the wetland.

**Chen et al** (2007) researched the impact of corrosive mine seepage on the well water in the neighborhoods Daboashan mine territory (Shangba town) and did a coordinated examination venture. The study range is well known for copper, zinc, lead and iron mines. The vast majority of the mines release their emanating into a mud holding impoundment (MRI) which is manufactured for surge water. Since the MRI is flooded the mine release is going into a tributary. Their evaluation strategy included examining from 112 well out of which 6 were chosen for long haul studies. At that point pH, electrical conductivity test, test for Cu, Pb, Zn, Cd, Fe and Mn by graphite heater nuclear assimilation spectrometry and Al estimation by inductively coupled plasma-nuclear outflow spectrometry (ICP-AES) were completed. After wards poisonous quality test utilizing *Daphnia carinata* was finished. Investigation on factual centrality of distinction between means was performed utilizing pearson connection. The outcomes demonstrate that every concoction parameter was variable amid the checking period. By and large, pH was  $2.9 \pm 0.3$ . Accordingly, centralization of different metals of potential harmfulness was additionally to a great degree high and was in place  $Zn > Cu > Pb > Cd$ . The amassing of these metals in the

water was 1.6, 21, 1.76 and 13 times higher. Consequences of well water propose that the groundwater in the Shangba floodplains have been influenced by the acidic watering system water and the most reduced pH recorded in QL is inferable from its nearest nearness to the inflowing watering system water of AMD source. Water gathered from the area nearest to the acidic watering system water source was intensely dangerous to the test creature (*Daphnia carinata*) even after 51 time weakening. It is likely that the amazingly high death rate of the neighborhood populace reported for the study region is in any event halfway identified with the large amounts of substantial metals, especially Cd in the drinking well water.

**Balistrieri et al** (2007) attempted to focus the synthesis of a stream that is affected by corrosive mine waste, and to assess overwhelming physical and geochemical techniques controlling the arrangement. They surveyed disintegrated metal speciation and poisonous quality utilizing a mix of research center, field and displaying studies. They found that estimations of pH increments from 3.3 to 7.6 and the aggregate of broke up base metal (Cd + Co + Cu + Ni + Pb + Zn) focuses diminishes from 6270 to 100 mg/L in the dynamic blending and response zones, downstream of the stream's conversion with corrosive mine seepage. Blending outlines and PHREEQC estimations demonstrated that blending and weakening influence the convergences of every broke up component in the span. Moreover, broke down Al and Fe focuses diminish because of mineral precipitation, though disintegrated convergences of Cd, Co, Cu, Ni, Pb and Zn diminish because of adsorption onto recently framed Fe encourages. The uptake of broke down metals by sea-going living beings relies on upon the watery speciation of the metals and energy of complexation responses between metals, ligands and strong surfaces. Diffusive slopes in slim movies (DGT) method and the Biotic Ligand Model (BLM) are utilized to evaluate the metal substance. Information from DGT units demonstrate that all broke up metal species are inorganic. BLM studies affirmed the DGT results. Computed intense lethality focuses are beneath LC50 values. Interestingly, labile Cu fixations surpass LC50 values for the life forms and also Criteria Continuous Concentration and Criteria Maximum Concentration at destinations <30 m downstream of the conjunction. These outcomes recommend that ecological conditions at locales nearest to the juncture of the stream and corrosive mine seepage ought not to bolster solid sea-going organic entities. Their study exhibited the significance of investigative demonstrating

strategy and incorporated geochemical water quality and danger lists to accomplish a comprehension of natural effects in complex environment.

**Bhuiyan et al** (2010) surveyed the overwhelming metal focus in mine seepage (watering system water) and groundwater frameworks in North-Western Bangladesh. They utilized contamination records and diverse multivariate methodologies (PCA and CA) to distinguish the contamination status and likely wellsprings of toxins in the study range. Their study included assessments of overwhelming metal contamination file (HPI), substantial metal assessment list (HEI) and level of pollution. In their evaluation they gathered thirty-two water tests, comprising of 20 from mine waste and adjacent wetlands (prefixed seepage water (DW)), 10 groundwater tests from boreholes, watering system pumps and hand-burrowed wells (prefixed groundwater (GW)) and 2 examples from coal mine unaffected territories (prefixed waterway water) and performed temperature, pH and conductivity, DO, COD, AAS tests, in this manner deciding physicochemical and basic properties of water. At that point contamination assessment records: overwhelming metal contamination lists, Heavy metal assessment file, Degree of defilement (Cd) were resolved which was trailed by Statistical examination. At that point the water tests were ordered and contamination source was recognized. Spatial similitudes and testing site gathering was done and connection lattice was framed.

## **2.2 Impact of coal on water**

Water is an essential component in the process of preparation of coal, coal washing and dusting suppression etc. To meet this requirement mines acquire surface or ground water supplies from nearby agricultural or domestic users. These water resources ones used are rarely returned after mining because of contamination from impurities present in the seam and also from the overburden. The other impacts of using water are

- Drainage of usable water from shallow aquifers
- Lowering of water levels in adjacent areas
- Contamination of usable aquifers below mining operation due to percolation of poor quality mine water.
- Increased run off of poor quality water and erosion from spoil piles
- Poor quality water flow to nearby streams

- Increases acidic or basic nature of water
- Increased dissolved solids, that dissolved solids
- Decreased BOD
- Increased turbidity
- Presence or increase in concentration of trace elements.

### **2.3 Pollution associated with coal washeries for beneficiation of coal**

Coal seam in some of the nations has drift origin, brought about private blending of mineral matter with coal, offering ascent to more powder substance. Coal washeries are to decrease cinder substance in coal. For coking and non-coking quality change, coal washeries are utilized. Coal having float starting point, coal-powder appropriation in the coal grid is so bury woven that coal is basically needed to pulverize to littler sizes for better liberation of coal and slag particles.

Coal beneficiation generally relies on upon gravity contrast in the middle of coal and powder particles in the wake of going through measuring.

Amid different operations in coal washeries a considerable measure of particulate matters and vaporous toxins are produced bringing about a genuine air contamination issue in the range. In addition, coal washeries discharge huge measure of solids and fluid waste creating genuine ecological issues.

The washeries diminish fiery debris substance of coal to 17.5% or less. This procedure devours clean water in the scope of 0.2 to 0.25 m<sup>3</sup>/ton of crude coal info.

The washeries are worked in the shut water circuit framework yet at the same time around 12-18% of crude water is released as effluent. Despite the fact that emanating is dealt with in settling tank however at times over-burdening results into disappointment of shut circuit framework. The rejects (15 to 25% of data) are dumped close accessible area without watching over steadiness of dump, thus dumps close to the stream bank cause disintegration of coal particles amid blustery season and amassing of fine coal particles on the base of waterway.

Despite the fact that a large number of the washeries have sufficient settling tanks however transfer of strong waste needed to be quickened, particularly in creating nations to check with the contamination. Legitimate reject dump administration is obliged to minimize soil disintegration. Another extremely helpful procedure of creating power with the assistance of washery rejects by utilizing eco-accommodating Fluidized Bed Combustion innovation. By receiving innovation which utilizes washery rejects, the transfer of fines and rejects can be used appropriately and monetarily, as coal of float birthplace require to pound coal before benefication and subsequently era of fines are more.

#### **2.4 Treatability study of the Washery Effluent**

According to the present environmental practice, it is necessary to treat the effluent water coming out of the tailing pond to remove the suspended solids and be recycled preferably without creating any pollution problem in the downstream water bodies and to maintain satisfactory water balance. The size of the suspended solids in the washery effluent were found to be less and they do not settle down easily. They tend to remain suspended in surface water for an indefinite duration. The colloids are destabilized or destroyed by allowing them to agglomerate or coagulate into larger ones and thus they can be removed effectively. The salt of Al and Fe are found to be suitable for this purpose. The treatment for the removal of suspended solid is based on the principle of an extended sedimentation.

## **Chapter-3**

# **SAMPLING AND MEASUREMENT**

## 2. SAMPLING AND MEASUREMENT

Water is the most well-known medium for transporting pulverized material in beneficiation plants and thus most coal partitions happens inside this medium.

More intricate estimations are frequently made in a research center obliging a water test to be gathered, saved, transported and dissected at another area. The procedure of water examining presents two huge issues. The main issue is the degree to which the specimen may be illustrative of the water wellspring of hobby. Numerous water sources shift with the time and area. The estimation may fluctuate regularly or from day to night.

The second issue happens as the example is expelled from the water source and starts to create substance balance with its new encompassing the specimen holder. Test holders ought to be of materials with insignificant reactivity and pre-cleaning the holder is essential.

Sample preservation might part of the way resolve the second issue. A typical method is keeping examples cool to moderate the rate of compound responses and stage change and dissecting the example at the earliest opportunity; however this just minimizes the progressions as opposed to counteracting them.

The goal of inspecting is to gather a part of material sufficiently little in volume to be transported advantageously but sufficiently extensive for explanatory purposes while still precisely hating the material being examined. This target suggests that the relative extents of every applicable part will be the same in the examples as in the material being examined and that the specimen will be taken care of in such a route, to the point that no critical changes in organization happen before the tests are made.

Every now and again, the goal of inspecting and testing is to exhibit whether proceeding with consistence with particular administrative prerequisites has been attained to. Tests are exhibited to the research facility for particular determinations, with the sampler being in charge of gathering a legitimate and delegate test.

Guarantee that the sample containers are clean and quality guaranteed before utilization. Utilization sample compartments that are clean and free of contaminants. Fill test holders without pre-rinsing with test; pre-rinsing results in loss of any included additive and infrequently

can predisposition comes about high when certain segments stick to the sides of the holder. Contingent upon determinations to be performed, fill the holder full or leave space for air circulation, blending, and so on. In the event that a container as of now contains additive, fare thee well not to overload the jug, as additive may be lost or weakened.

Water and effluent tests were gathered, specifically, crude water information, fine coal dance submerged, coarse coal dance submerged, and slurry lake water. The water/emanating examples were gathered by prescribed strategies. The water tests were gathered in glass/plastic holders as prescribed in the standard for distinctive parameters. The examples were filled in the cups totally and stoppered in such a path, to the point that there was no air over the specimen. Spot examining was finished. A percentage of the parameters, for example, pH, and temperature were examined in situ and for investigation of different parameters, additives were included as proposed in the standard.

### **3.1 SAMPLE PROCEDURE**

#### **3.1.1 Collection of sample:**

- It is guaranteed that all testing hardware is clean and quality-guaranteed before utilization. Utilization test compartments that are clean and free of contaminants.
- Sample containers were filled without pre-rinsing with sample; pre-rinsing results in loss of any pre-added additive.
- Special safeguards are vital for tests containing follow metals.
- Since numerous constituents may be display at low fixations, they may be absolutely or mostly lost or effortlessly tainted when legitimate examining and conservation methods are not followed.
- The followings were recorded during sample collection
  - General information
  - Sample identification number
  - Location
  - Sample collector

### 3.2 Sample Collection from the Washery

The samples from the washery are collected from different places in the washery and the flow sheet of a general washery is given below followed by sample collection.

The Process Flow sheet of the Washery is as under:

- Crushing of coal down to 40mm in two stages .Primary Crusher for crushing down to- 200 mm in double roll crusher and secondary crusher for crushing down to -40 mm in the double roll crusher.
- Stocking of 80-0 mm crushed coal in 10000 tone slit type bunker.
- Screening of 80-0 mm Coal at 10 mm in vibratory screens to produce two fractions viz. 80-10- mm and 10-0 mm.
- De-dusting of 10-0 mm coal in de-dusters to recover dry fines as far as possible. The recovered fines are mixed with clean coal.
- Preparation of 80-10 mm coal in a 480 TPH, 4 product Batac Jig to produce clean coal, low ash middling, high ash middling and rejects.
- De-sliming of 10- 0 mm de-dusted coal in de-sliming screen.
- Preparation of 10-00 mm de-slimed coal in a 300 TPH, 4 product Batac Jig.
- To produce clean coal, low ash middling, high ash middling and rejects. Dewatering of clean coal from coarse coal Batac coal Jig dewatering screen.
- Crushing of low middling in the size range 80-10 mm down to -10 mm in impact crusher. The crushed middling are then fed to a set of HM Cyclones along 10-0.5 mm low ash middling from small coal Batac Jig to produce clean coal and middling. A magnetite arrangement has been provided for the purpose. The scheme also provides arrangement for recovery of magnetite in two stage magnetic separator.
- Dewatering of clean coal from small coal Batac Jig & HM cyclones initially in dewatering screen sand finally in centrifuge.
- Initial dewatering of high ash middling from small coal Batac Jig and HM cyclones dewatering screen and finally in Centrifuge.
- Thickening of 0.5 mm slurry in a radial thickener.
- Preparation of 0.5 mm thickened slurry in flotation cells in disc filters and the filter cake is mixed with clean coal.

- Flotation tailings are fed to a vortex thickener, the underflow from which is charged to tailings pond.
- Arrangement for stocking of clean coal and middlings.
- Stocking of reject in a 300 T reject bin and disposal by truck.

A total of 12 samples, 4 from each of the three different coal washeries are collected and brought.

The four samples vary with their location in the washery. They are

1. Raw water
2. Fine coal Jig water
3. Coarse coal jig water
4. Slurry pond water

The three coal washeries selected for this study are of CCL washeries. They are

1. Kargali and Bokaro coal washery
2. Rajrappa coal washery
3. Kedla coal washery

The quantity of each sample is about 2 liters.

### **3.3 Measurement**

Water quality is the physical, chemical and biological characteristics of water. In this study, the parameters are tested and analyzed by the guidelines prescribed by American Public Health Association (APHA, 1985) and Central Pollution Control Board (CPCB).

The characteristics of water or the parameters of water are widely placed in four categories, namely Physical parameters, Metals, Inorganic Non-metallic contents or chemical compounds, Organic parameters.

**Physical Parameters:** This deals primarily with measurement of the physical properties of a sample. The determinations included here are Turbidity, Conductivity, Total Solids and Temperature.

**Metals:** The effect of metals in water and wastewater range from beneficial through troublesome to dangerously toxic. Some of the metals are required to be present; but some may be unfavorable to the aquatic life. The toxicity or beneficiary of a metal depends on its concentrations.

**Chemical parameters and Inorganic Non-metallic Constituents:** Acidity, pH, alkalinity, various forms of chlorine, nitrogen and phosphorous are the considerable parameters while analyzing for inorganic components present in water. These parameters may have the effect on water quality in many number of ways.

**Organic parameters:** Direct determination of the Organic diversity and the ability of water to sustain life are troublesome. Hence parameters like Dissolved Oxygen content, Bio- chemical Oxygen Demand, Chemical Oxygen Demand and Total Organic Carbon content helps in deducing inference regarding ability of the water to sustain life in it. So the above parameters are to be determined with an equipment having utmost accuracy.

### **3.3.1 Multi Water Quality Checker U-50 Series**

pH, Oxidation and Reduction potential, Turbidity, Suspended Solids, Salinity, DO are the parameters that are calculated by Multi Water Quality Checker U-50 Series.

The U-50 Series Multi Water Quality Checker highlights an incorporated control unit and sensors. It is fit for making a most extreme of eleven synchronous estimations for different parameters, and is ideal for utilization in the field. The U-50 Series is planned considering on location convenience, gives a wide assortment of capacities, and can be utilized for water quality estimations and reviews of stream water, groundwater, and waste water.

#### **3.3.1.1 Measurement of pH**

##### **Principle of measurement of pH**

U-50 arrangement utilize the glass cathode strategy for pH estimations. The glass electrode strategy measures a potential contrast between the glass film for pH and the reference cathode.

### **3.3.1.2 Measurement of DO**

#### **Principle of measurement of DO**

Dissolved oxygen (DO) alludes to the measure of oxygen that is contained in water. The centralization of disintegrated oxygen is for the most part given as mg/L or as a rate esteem (the broke down oxygen immersion proportion). Broken down oxygen is key for keeping up the self-decontaminating capacity of streams and oceans furthermore for fish to live. The amassing of broke down oxygen goes about as a marker of water quality. It is regularly measured when handling waste water and overseeing water quality. The polarographic oxygen sensor is an encased sensor wherein voltage is connected to a cathode made of a valuable metal, (for example, gold or platinum) and an anode likewise made of a valuable metal, (for example, silver) by means of an outside circuit, and a top with an oxygen penetrable stomach (film) is loaded with electrolyte arrangement. The convergence of broke down oxygen can be measured by measuring the present relative to the measure of diminished oxygen when oxygen that has scattered through the oxygen porous stomach creates a reductive response on the surface of the dynamic anode (gold). The technique for measuring disintegrated oxygen taking into account the above guideline is known as the Membrane Electrode Method. Contrasted with the Chemical Analysis Method, which requires entangled pre-processing to mitigate the impact of lessened materials and oxidizing materials, this strategy permits disintegrated oxygen to be measured effectively. It is likewise simple to expel undesired development from the silver anode by cleaning and cleaning if a separator frames on it because of oxidation, making the technique reusable.

### **3.3.1.3 TDS**

TDS is short for Total Dissolved Solids and means the aggregate broke down strong sum. The conductivity of an answer is influenced by the measure of saltiness, minerals, and broke up gasses. That is, conductivity is a file that demonstrates the aggregate sum of all substances in the arrangement. Of these substances, TDS demonstrates just the measure of disintegrated solids. TDS can be utilized for an examination of the condition of substances made out of a solitary segment, for example, NaCl. Be that as it may, the utilization of TDS for the examination of arrangements of diverse sorts causes genuine lapses.

Conductivity and TDS are expressed by the following formulas.

Conductivity in SI units (S/m)..... TDS (g/L) = L (S/m) × K × 10

TDS (g/L) = L (mS/m) × K ÷ 100

Conductivity in the old units (mS/cm)..... TDS (g/L) = L (mS/cm) × K

K = TDS coefficient

Initial settings use the values listed in the table (Page 80) that generally uses TDS coefficients.

For accurate TDS comparisons, find the TDS coefficient from measured conductivity values.

Then set the value thus obtained and make measurements.

#### **3.3.1.4 Salinity**

The U-50 arrangement is intended to ascertain saltiness and additionally alternate parameters. Note that the "saltiness" here is the saltiness of ocean water. There is a steady connection in the middle of conductivity and saltiness at specific temperatures. Along these lines, if information on the conductivity and temperature are accessible, the comparing saltiness can be known. At the end of the day, the saltiness estimation of the U-50 arrangement is in view of the guideline of figuring the salt substance, making utilization of the deliberate estimations of conductivity and temperature. Note consequently, that deliberate consequences of all substances whose conductivity is recognized are shown as saltiness. Case in point, the deliberate result is shown as NaCl focus, regardless of the possibility that indeed the specimen segment is, hydrochloric corrosive (HCl).

#### **3.3.1.5 Measurement of Turbidity**

U-50 arrangement can perform adjustment utilizing formalin (NTU) or kaolin standard arrangements as a turbidity standard arrangement. Nonetheless, units for the arrangement utilized for alignment ought to be shown in estimations. Try not to utilize more than 400 mg/L of kaolin standard arrangement in light of the fact that it expands precipitation rate, bringing about estimation slip.

#### **3.3.1.6 Measurement of Oxidation reduction potential (ORP)**

##### **Principle of ORP measurement**

ORP is an abbreviation for oxidation-reduction potential. ORP is the energy level (potential) determined according to the state of equilibrium between the oxidants ( $MZ^+$ ) and reductants  $M(Z - N)^+$  that coexist within a solution.

### **3.3.2 Flame photometer 1382**

The parameters such as Sodium, Potassium, Magnesium and Calcium were carried out in Flame Photometry apparatus.

This Flame photometer 1382 helps in the detection of sodium, potassium, calcium and lithium. It uses the latest microcontroller technology and advanced engineering techniques for analyzing of these parameters with highest accuracy.

Different features:

1. Microprocessor with printer interface
2. Multiple calibration of curve
3. Curve calibration programmability
4. Automatic gas cutoff system
5. Data storage facility
6. Auto flame failure detection unit
7. Setup data storage facility
8. Four parameters measurement in a single aspiration
9. Direct results in ppm and meq
10. Online help key

Principle and working:

The standard solution is suctioned through the Automiser unit. The solution, air and fuel are blended inside the mixing chamber to change over into fine particles of fog then it is splashed into the fire. The concentration of the components reflected through the change in color of the lame. The radiation fire goes through the detecting unit and the narrow band of obstruction channel which permits the particular portrayed radiation to the photo detector. It analyses the radiation and showcase the output on the LCD screen.

**Table: 1 (Specifications of Flame Photometry used for the measurement)**

Mode	General
Range	Na: 0-100ppm K : 0-100ppm Ca: 0-100ppm Li : 0-100ppm
Sensitivity	Na:0.5ppm Li:0.5ppm K: 0.5ppm Ca: 15ppm
Resolution	0.1 ppm
Display	20 x 4 alphanumeric LCD with backlit
Flame system	LPG and dry oil free air
Detector	Silicon photo Diode
Calibration	Up to 5-Point calibration with curve fitting software
Gas cut-off	Automatic
Flame failure	Auto detection
Atomiser	Axial flow type
Ignition system	Auto ignition
Power	230 V $\pm$ 10% AC, 50 Hz
Dimension	285 x 255 x 210 mm
Weight	7.5 kg in approx.

### **3.3.3 Determination of Metals by Atomic Absorption Spectrometric**

Metal substance of water can be dead set through different routes, for example, Titration Method, Phenanthroline Method, and Atomic Absorption Spectrometric Method. Out of which the Atomic Absorption Spectrophotometry (AAS) is the most delicate, fast and advanced system. The precision of this method is high. So in this work for determination of metals AAS is utilized.

Atomic absorption spectrophotometry: In flame atomic absorption spectrometry, a sample is suctioned into a flame and atomized. A light beam is facilitated through the fire, into a monochromatic, and onto a detector that measures the measure of light devoured by the atomized part in the fire. For some metal, nuclear assimilation shows better sensitivity over flame outflow. Since each metal has got its own retention wavelength a source light made out of the parts is used, this indicate the strategy by and large far from ghostly or radiation impedance. Most

nuclear assimilation instruments moreover are arranged for operation in a discharge mode, which may give better linearity to a couple of segments.

There is reliably a fix of "concoction obstruction" which rises when the fire is not adequately solid to discrete the molecules realizing nonattendance of ingestion by iotas.

### **Apparatus and Reagents:**

1. Atomic absorption spectrometer
2. Burner
3. Readout
4. Lamps
5. Pressure reducing valves
6. Vent
7. Air and acetylene
8. Metal free water
9. Standard solution

### **Procedure:**

1. Sample is digested for the use during estimation.
2. Suitable hollow cathode light is introduced according to the metal whose substance is craved to be discovered and fitting wave length is chosen for the distinctive metals. The table of wavelength according to metal and sensitivity is given beneath.
3. Opening width is set by proposed setting for the component being measured and after that current is turned on and balanced as recommended by the maker, and afterward the instrument is left to warm-up until energy source settles for around 10 to 20 min.
4. Wavelength is streamlined by conforming wavelength dial until ideal energy increase is obtained.

5. After introducing suitable burner head, and permitting air current according to greatest sensitivity acetylene is permitted and fire is lighted.

6. Adjustment is performed by suctioning blank samples and standard examples and recording the absorbance of the particular ones.

**Table: 2 (Suggested Wavelength for Different Metals during the use of Atomic Absorption Spectrophotometry)**

Element	Wavelength (nm)
Al	328.1
Cd	228.8
Cr	357.6
Cu	324.7
Fe	248.3
Mn	279.5
Ni	232.0
Pb	283.3
Zn	213.9

7. In the wake of getting the adjustment plot in the middle of fixation and absorbance, sample is analyzed for the specific metal.

8. The concentration of the metal is specifically recorded from the computerized show or read out.

9. The fire is then quenched by turning off the acetylene initially took after via air.

**Calculation:**

The results are directly noted from the instrument.

## **Chapter-4**

# **RESULTS AND DISCUSSIONS**

## 4. RESULTS AND DISCUSSIONS

Processing of coal and minerals includes exchange of potential pollutants from one sector of the environment into another. Changes happen in water quality amid coal beneficiation. Transforming results basically underway of immense amounts of suspended material, other than different pollutants in the effluent produced.

Washery name: **Kedla Coal Washery (CCL)**

- Sample points: 1. Raw water  
2. Fine coal jig water  
3. Coarse coal jig water  
4. Slurry pond water

Mg/l is taken as the unit for all the parameters until specified and BDL is below detectable limit

Sl.No	Parameter	Sample 1	Sample 2	Sample 3	Sample 4	Below detection limit	MoEF-Schedule VI Indian standards
1	Color	Acceptable	Acceptable	Acceptable	Acceptable		Acceptable
2	Odor	Acceptable	Acceptable	Acceptable	Acceptable		Acceptable
3	pH	7.5	6.2	6.3	6.3	<0.01	5.5-9.0
4	Oxidation and reduction potential(mv)	203	212	212	219		
5	Turbidity(NTU)	133	145	146	141		
6	Total dissolved solids(g/l)	0.14	0.23	0.23	0.2		
7	Salinity(ppt)	0.7	0.7	0.7	0.7		-
8	DO	6.8	7.1	7.2	7.2		
9	Arsenic	BDL	BDL	BDL	BDL	<0.001	0.2
10	Lead	0.006	0.006	0.006	0.007	<0.001	0.1
11	Cadmium	BDL	BDL	BDL	BDL	<0.001	2.0
12	Iron	0.02	0.02	0.02	0.02	<0.001	3.0
13	Nickel	0.003	0.003	0.003	0.003	<0.001	3.0
14	Copper	0.01	0.015	0.01	0.018	<0.001	3.0
15	Zinc	0.003	0.004	0.005	0.004	<0.001	5.0
16	Chromium	0.012	0.016	0.012	0.019	<0.001	2.0
17	Sodium	12.6	20.8	20.8	20.6	<0.02	-
18	Potassium	1.7	6.8	6.9	7.3	<0.02	-
19	Magnesium	24.3	58.7	55	27	<0.02	-
20	Calcium	57	147	140	156	<0.02	-
21	Manganese	BDL	2.4	2.3	2.1	<0.05	2.0
22	Nitrate nitrogen	2.5	2.7	2.8	2.6	<0.01	10.0

**Table: 3(Results of samples from Kedla Coal washery)**

Washery name: **Rajrappa Coal Washery (CCL)**

Sample points  
 1. Raw water  
 2. Fine coal jig water  
 3. Coarse coal jig water  
 4. Slurry pond water

mg/l is taken as the unit for all the parameters until specified

BDL is below detectable limit

**Table: 4 (Results of samples from Rajrappa Coal washery)**

Sl.No.	Parameter	Sample 1	Sample 2	Sample 3	Sample 4	Below detection limit	MoEF-Schedule VI Class 'a' standards
1	Color	Acceptable	Acceptable	Acceptable	Acceptable		
2	Odor	Acceptable	Acceptable	Acceptable	Acceptable		
3	pH	6.9	6.26	6.3	6.27	<0.01	5.5-9.0
4	Oxidation and reduction potential(mv)	203	217	217	219		
5	Turbidity(NTU)	116	131	137	110		
6	Total dissolved solids(g/l)	0.135	0.93	0.891	0.809		
7	Salinity(ppt)	0.6	0.6	0.6	0.6		-
8	DO	6.6	7.16	7.15	7.19		
9	Arsenic	BDL	BDL	BDL	BDL	<0.001	0.2
10	Lead	0.012	0.016	0.014	0.014	<0.001	0.1
11	Cadmium	BDL	BDL	BDL	BDL	<0.001	2.0
12	Iron	0.033	0.033	0.037	0.037	<0.001	3.0
13	Nickel	BDL	BDL	BDL	BDL	<0.001	3.0
14	Copper	0.006	0.014	0.014	0.008	<0.001	3.0
15	Zinc	0.014	0.016	0.015	0.016	<0.001	5.0
16	Chromium	0.006	0.006	0.006	BDL	<0.001	2.0
17	Sodium	13.7	24.3	21.6	21.3	<0.02	-
18	Potassium	2.3	7.1	7.4	7.1	<0.02	-
19	Magnesium	6.35	43	28	46	<0.02	-
20	Calcium	25	138	138	132	<0.02	-
21	Manganese	0.017	2.1	2.0	2.4	<0.05	2.0
22	Nitrate nitrogen	2.3	2.8	2.5	2.6	<0.01	10.0

Washery name: **Kargali Coal Washery (CCL)**

Sample points  
 1. Raw water  
 2. Fine coal jig water  
 3. Coarse coal jig water  
 4. Slurry pond water

mg/l is taken as the unit for all the parameters until specified

BDL is below detectable limit

**Table: 5 (Results of samples from Kargali Coal washery)**

Sl.No.	Parameter	Sample 1	Sample 2	Sample 3	Sample 4	Below detection limit	MoEF-Schedule VI Class 'a' standards
1	Color	Acceptable	Acceptable	Acceptable	Acceptable		
2	Odor	Acceptable	Acceptable	Acceptable	Acceptable		
3	pH	6.7	4.44	4.4	4.3	<0.01	5.5-9.0
4	Oxidation and reduction potential(mv)	210	278	278	279		
5	Turbidity(NTU)	123	181	181	167		
6	Total dissolved solids(g/l)	0.105	0.135	0.135	0.129		
7	Salinity(ppt)	0.1	0.1	0.1	0.1		-
8	DO	6.8	8.47	8.49	8.49		
9	Arsenic	BDL	BDL	BDL	BDL	<0.001	0.2
10	Lead	0.01	0.013	0.011	0.011	<0.001	0.1
11	Cadmium	BDL	BDL	BDL	BDL	<0.001	2.0
12	Iron	0.02	0.02	0.02	0.02	<0.001	3.0
13	Nickel	0.03	0.03	0.03	0.03	<0.001	3.0
14	Copper	0.010	0.013	0.011	0.019	<0.001	3.0
15	Zinc	0.001	0.002	0.002	0.002	<0.001	5.0
16	Chromium	0.010	0.013	0.010	0.018	<0.001	2.0
17	Sodium	12.3	20.6	20.5	20.3	<0.02	-
18	Potassium	1.7	6.0	6.8	5.8	<0.02	-
19	Magnesium	5	40	28.6	47.3	<0.02	-
20	Calcium	20.2	136	136	133	<0.02	-
21	Manganese	0.018	1.9	2.4	2.8	<0.05	2.0
22	Nitrate nitrogen	2.4	3.0	2.5	2.8	<0.01	10.0

The washing operation to which the coal is subjected to decide the concentration of suspended solids. In fine coal jigs, the coal undergoes to rough strengths which generates large number of fines as observed in the three washeries. The process water that comes from the fine coal jig contains more number of solids than the process water coming from coarse coal jig in the washeries. In the Rajrappa coal washery this concentration of solids had large distinction from raw intake water (135 mg/l) and fine coal jig water (930 mg/l) when compared to the other two washeries, as it was negotiable in the both.

The washery tailings are pumped to the settling or slurry lakes, wherein the fine solids continuously settle down and then the release of clear flood water is done. The concentration of dissolved solids in the slurry lake fluctuates relying on the settling rate. It was discovered to be 129 mg/l on account of Kargali washery, 219 mg/l on account of Kedla coal washery and 809 mg/l on account of Rajrappa coal washery. The stream from the settling lakes now and again contains tremendous measure of fines. This may be either because of deficient recovery or because of recovery before the completion of sedimentation happening in the slurry lake. Therefore, alongside the seepage from the coal stockpiling and refuse piles, flood from the settling lakes additionally on occasion adds to contaminating the regular watercourse.

Thus, an endeavor is made in the washeries to boost water reuse keeping in mind the end goal to diminish the amount of effluent released out from the washery. The innovation made to evacuate dissolved material is the mechanical dewatering and sedimentation. For this method the thickeners are utilized that assume the double part for purifying process water and thickening of the fines as portrayed before. The flow which comes is directly pumped to the pressure or vacuum filters which is then directed to the settling lakes from the thickener.

The properties of water are highly influenced by the dissolved minerals or salts. A few salts and minerals, for example, sulfates and chloride of the antacid and soluble metals, promptly break up in water which may essentially change the pH in this way.

As it is a known fact that the mineral matter decreases in the coal through the beneficiation process but a few trace elements are also diminishing in this process. Trace elements are for the most part diminished by this beneficiation where the degree is quite fluctuating for diverse

components. All in all, the components that connected with mineral matter are promptly uprooted than that are fundamentally naturally bound. In normally utilized coal processing systems, numerous follow components are amassed in overwhelming division. In this manner, despite the fact that, uproot of some follow components are favorable, particularly those of environmental importance, from a few coals, which results in an associative increment in the rejects of the coal beneficiation process. Works are being carried in the US and in India additionally to demonstrate the conveyance of follow components in the different particular gravity portions of coal in research center environment.

The pH is decreased in all the three washeries when the process water and the raw water are compared. The raw water intake of Kargali coal washery has the pH of 6.7 which is decreased to 4.4 of the effluent from the fine coal jig water. The raw water intake of Kedla coal washery has the pH of 7.5 which is decreased to 6.2 of the effluent from the fine coal jig water. The raw water intake of Rajrappa coal washery has the pH of 6.9 which is decreased to 6.26 of the effluent from the fine coal jig water.

As the sulfides and pyrites displayed in coal are insoluble but their oxidation to ferrous sulfate acids results in bringing down the pH of the process water and also can be a primary reason this decrease in pH in the washeries. Then again, XRD examination was not carried out at this stage to give the mineralogical investigation.

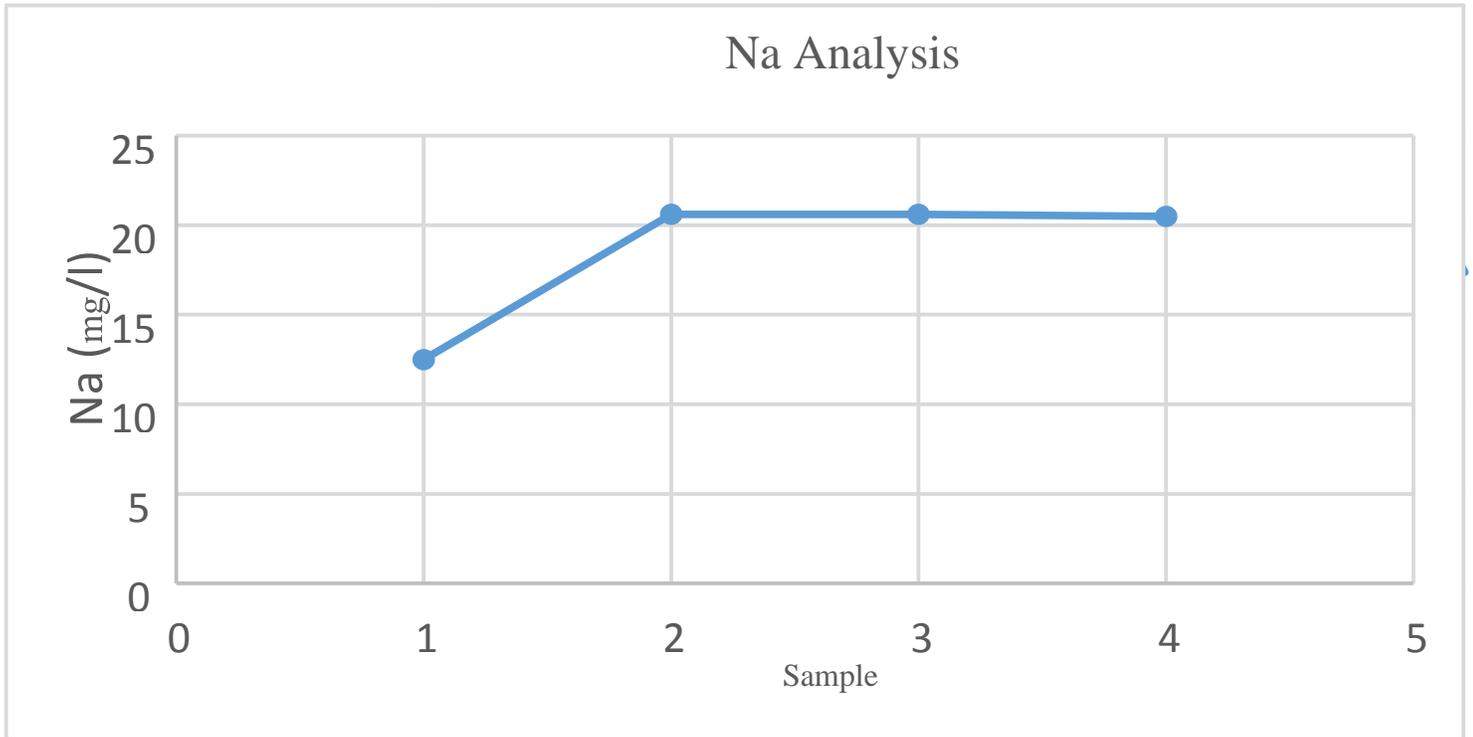
In the previous works the arrival or the dissolving of metals into water during the coal beneficiation process has been accounted. The metals reported were Al, Co, Mn, Cu, Pb, Ca, Fe, Ni, Mg, Zn and Pb. The following series gives us the draining rate the above mentioned metals; Mn>Ca>Mg>Zn>Pb>Fe>Ni>Cu>Co>Al. Except iron, estimations of sodium, potassium, magnesium, calcium were additionally have a large amount of variation when the values of the three coal washeries, Kedla, Rajrappa and the Kargali coal washery are taken into consideration. This consideration is done between the rejects of the washery and the fine coal jig water of the washery. In Indian coal, for the most part the convergence of iron has high difference than the

components, which are sodium, potassium, magnesium and calcium. In Indian Manganese have been accounted for as a minor component.

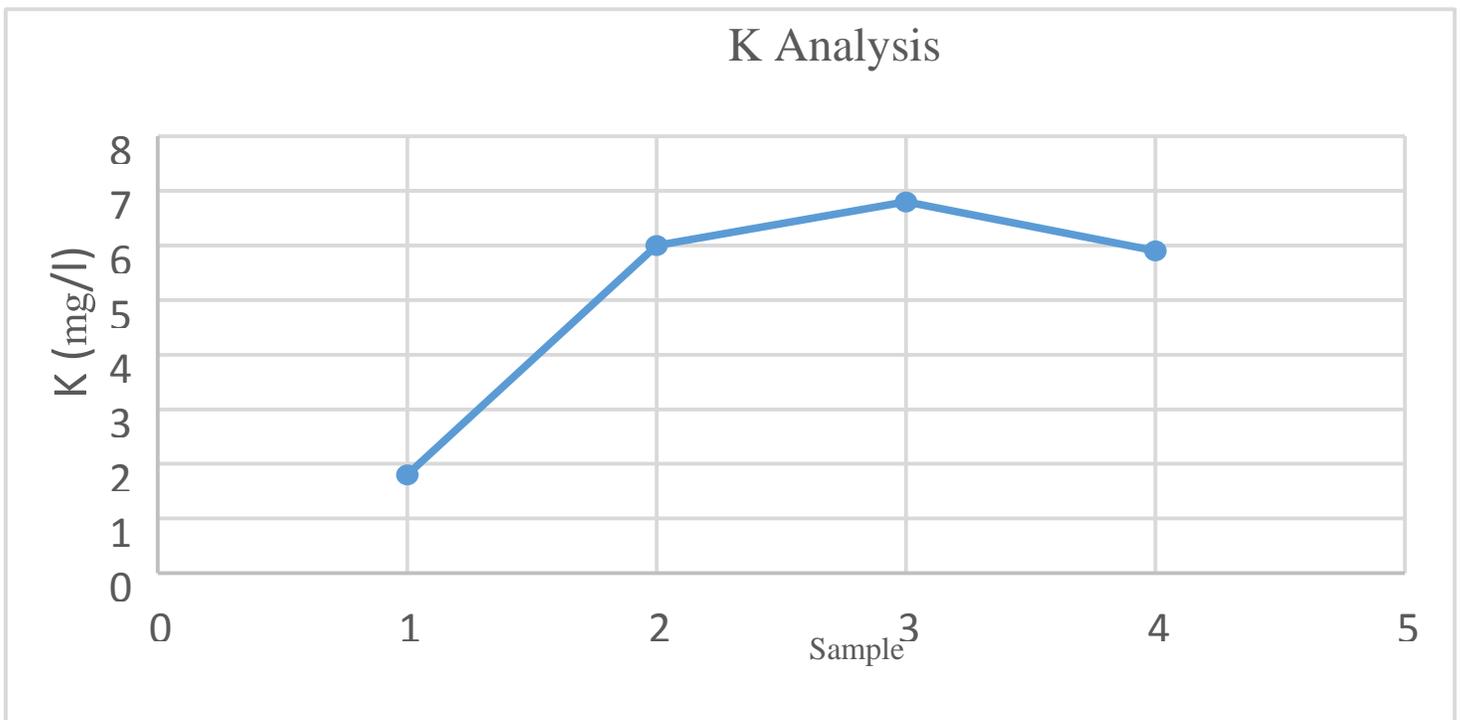
In the Kedla coal washery the manganese concentration was discovered to be more than the allowable limit in the process water than the concentration of manganese found in the raw intake water. The allowable limit of manganese as per standards is 2.0 mg/l, but the effluent from the fine coal jig water has 2.5 mg/l and that in slurry lake was 2.1 mg/l which is more when compared to the raw water intake having a manganese content of <0.5 mg/l. In the same way when the other washeries are considered i.e. the Kargali and the Rajrappa, the Mn substance introduced in process effluent was 2.8 and 2.5 mg/l which is higher than that present in raw water (i.e. 0.018 mg/l) and is likewise higher than as far as possible.

As this substance, Manganese is a solvent from acidic to neutral pH because the free oxygen responds to metallic components, we can say that manganese is getting dissolved in the process water. This can also be explained from watching the pH of the process water which having less than the raw water intake of the washery.

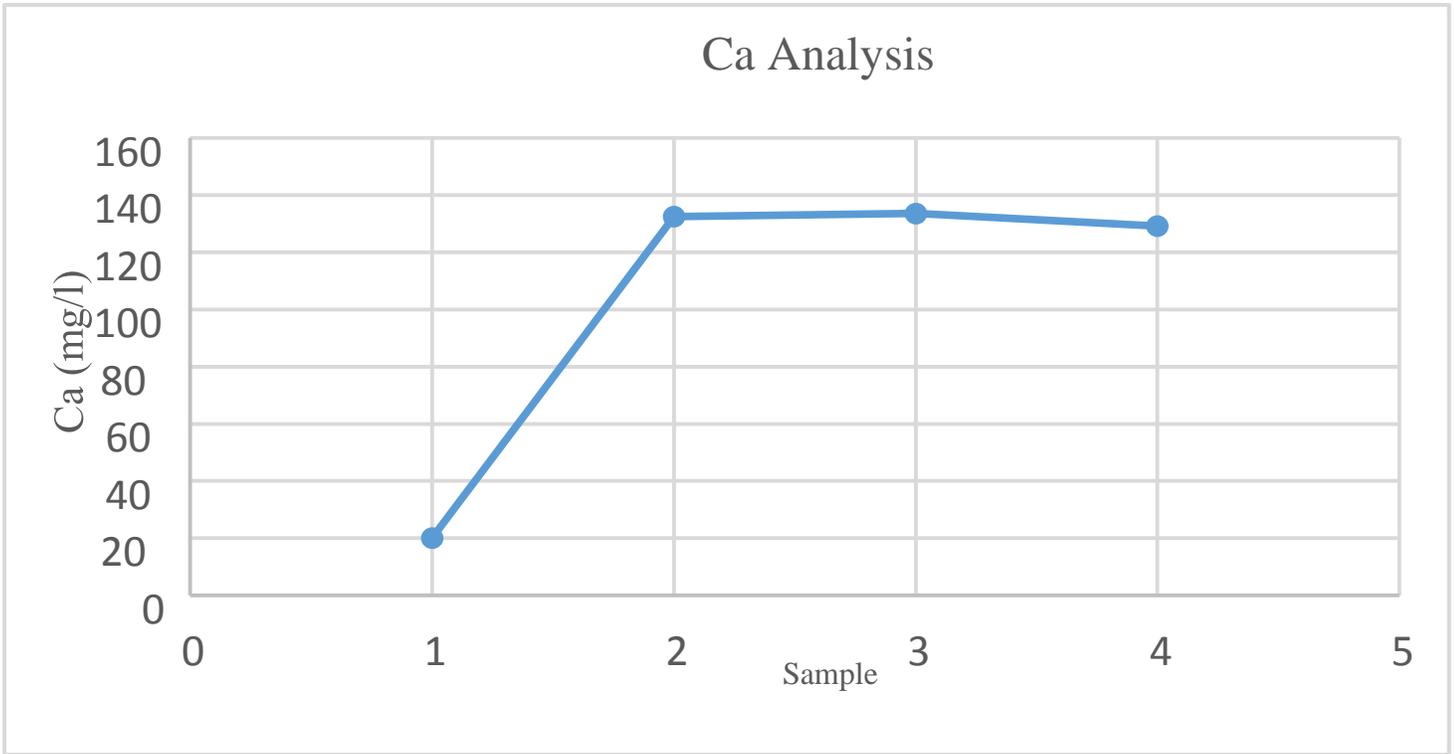
As it is a known fact that these Na, K, Mg, and Ca dissolve in water, the Na, K, Ca, and Mg found to be higher in the process water than in the raw water. Figs. 1(a), (b), (c), (d), (e); 2(a), (b), (c), (d), (e) and 3(a), (b), (c), (d), (e) are the plots of Kargali, Kedla and Rajrappa washery, for Na, K, Mg, and Ca individually.



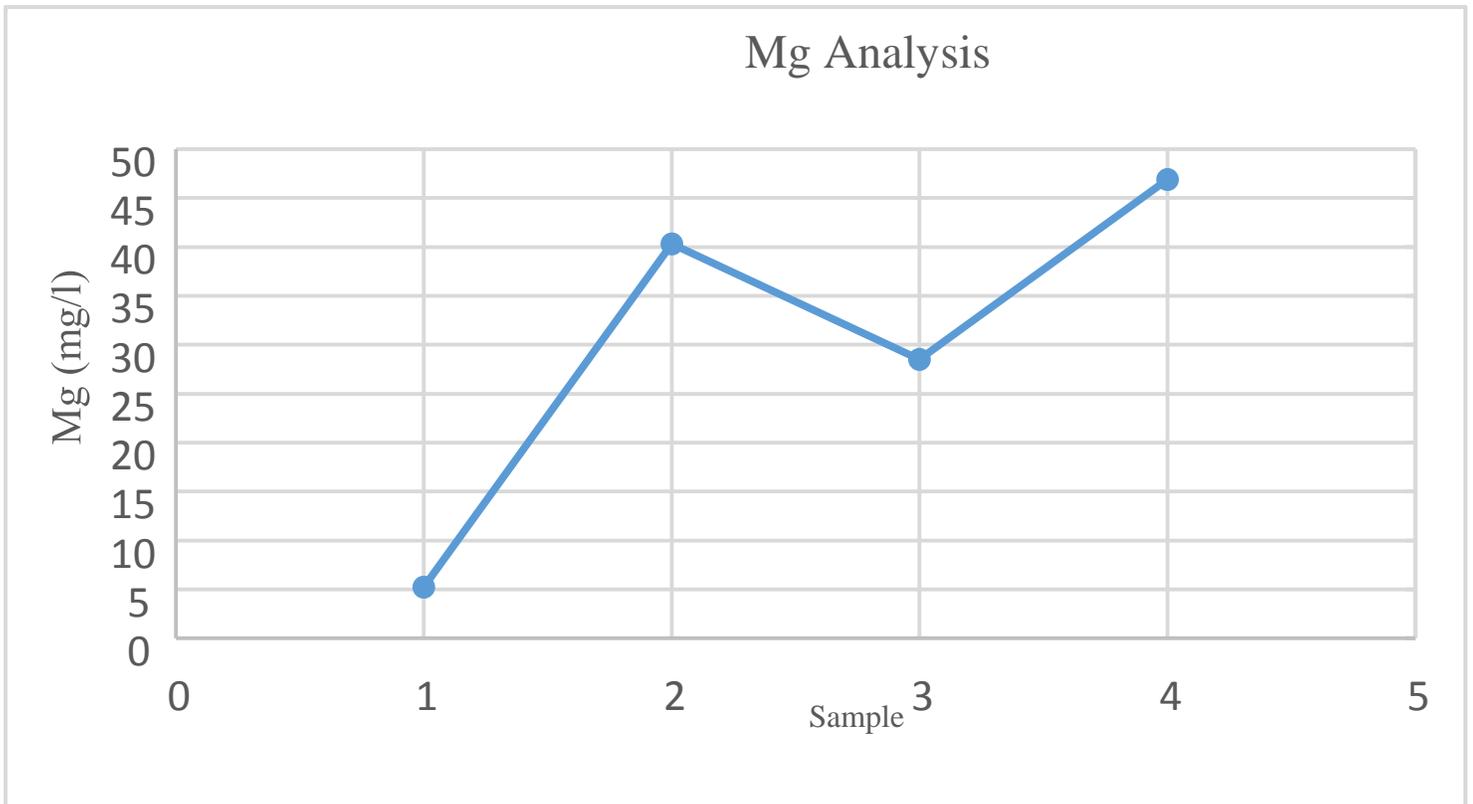
**Fig: 1(a) Plot for the Sodium of Kedla Coal Washery of Kedla Coal Washery**



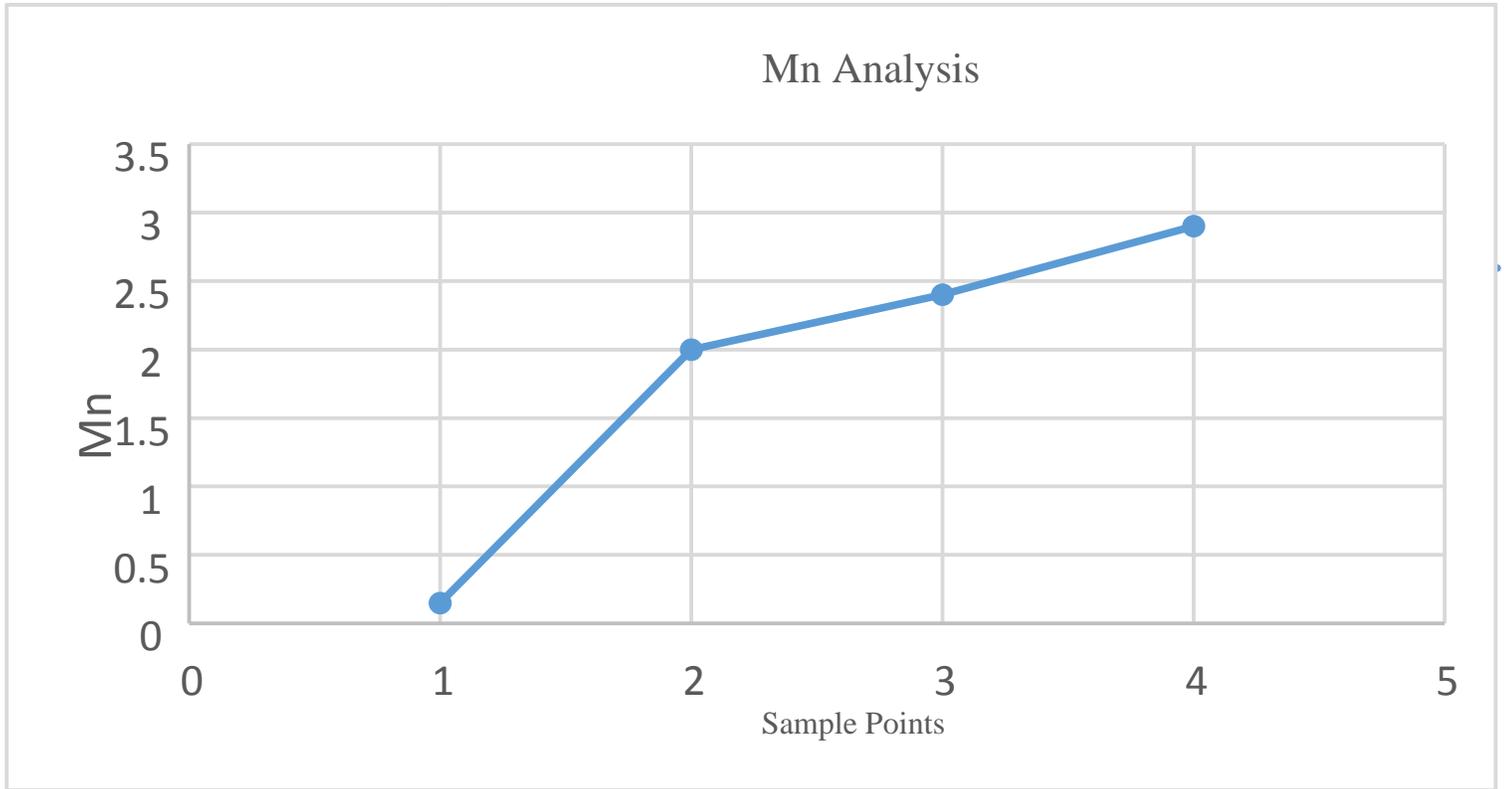
**Fig: 1(b) Plot for the Potassium of Kedla Coal Washery**



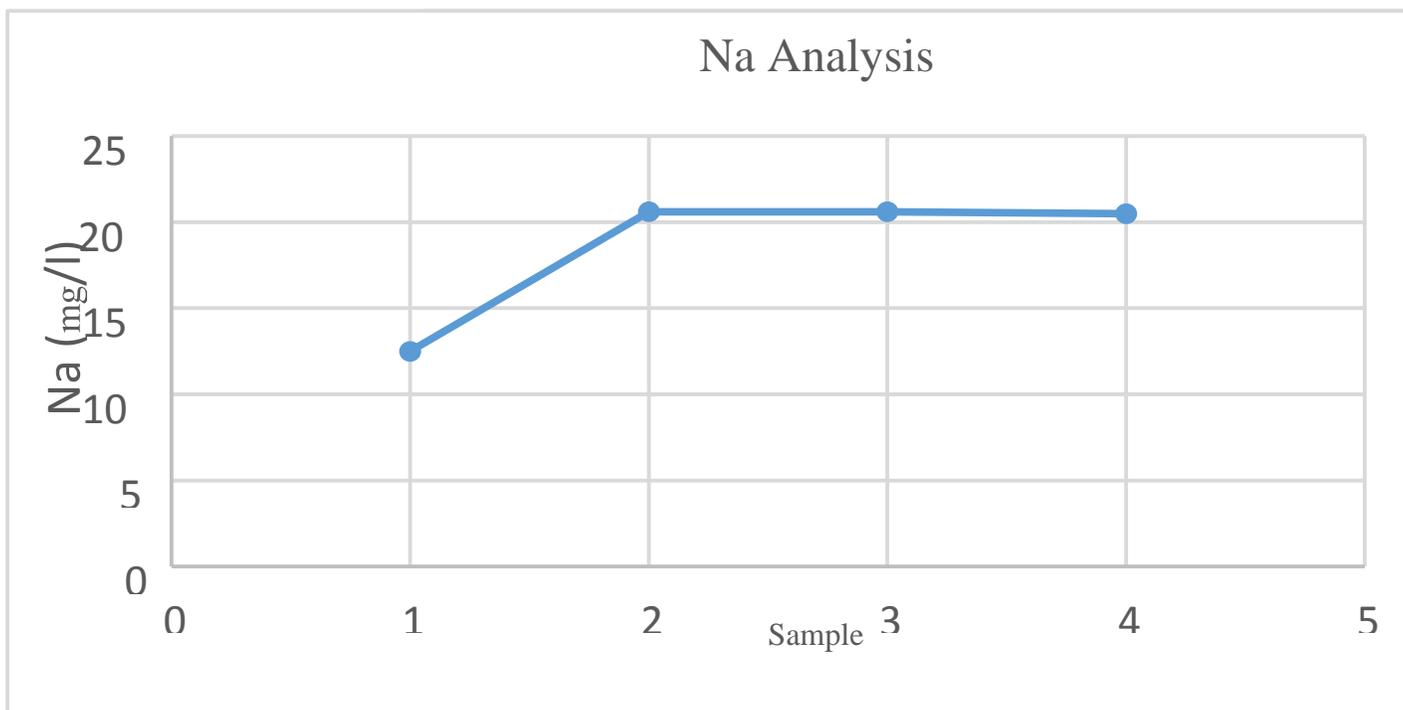
**Fig: 1(c) Plot for the Calcium of Kedla Coal Washery**



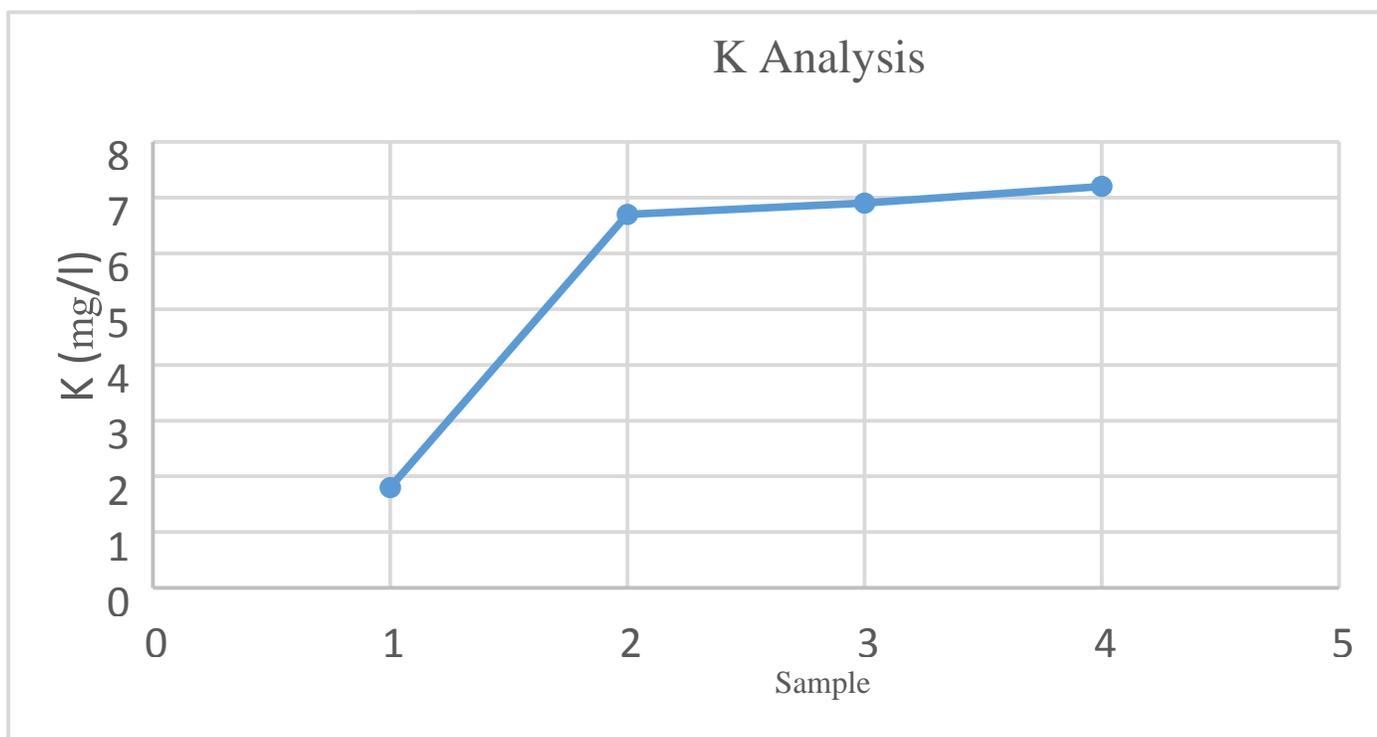
**Fig: 1(d) Plot for the Magnesium of Kedla Coal Washery**



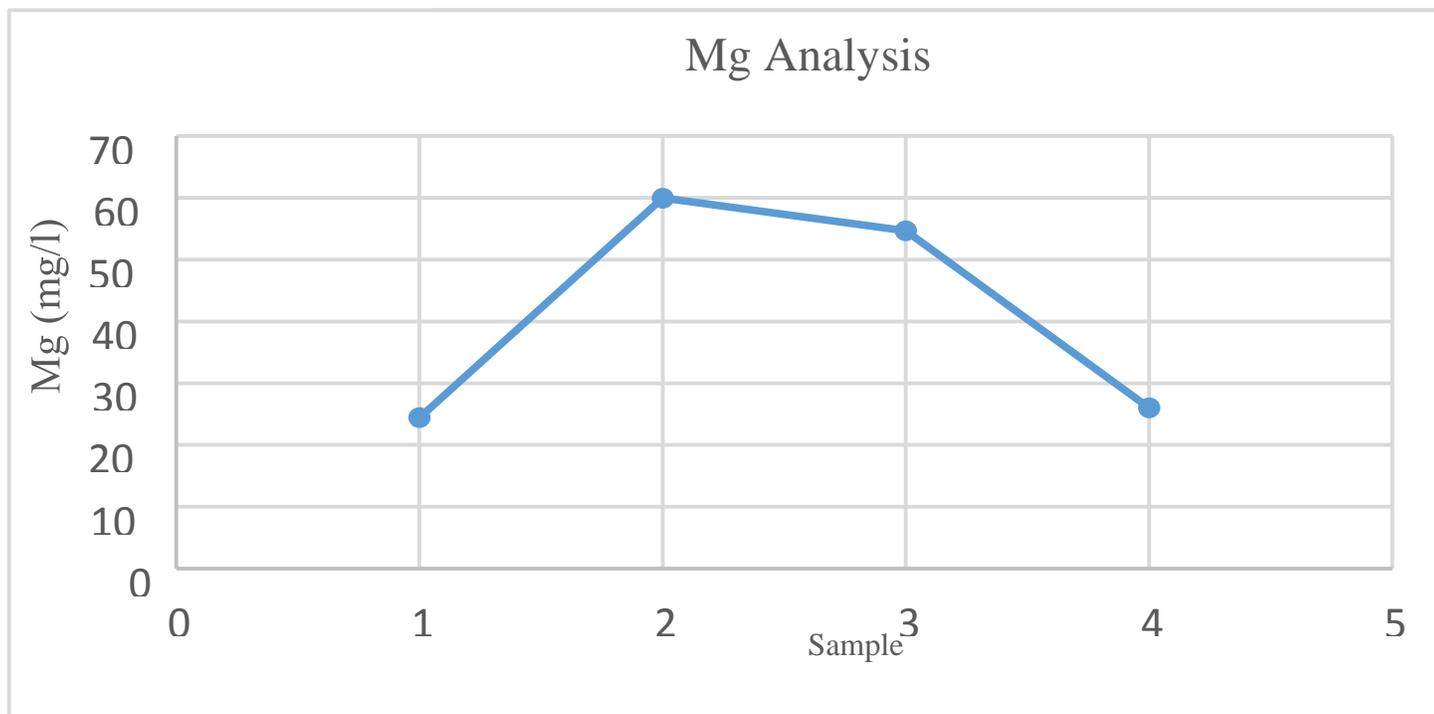
**Fig: 1(e) Plot for the Manganese of Kedla Coal Washery**



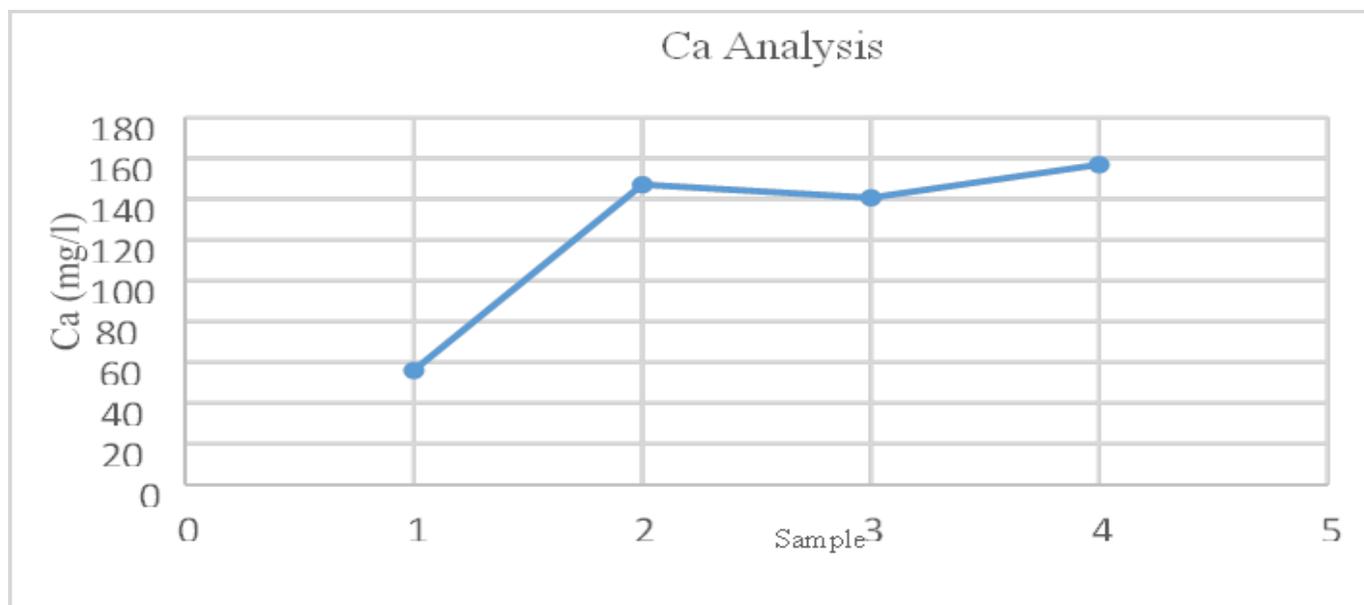
**Fig: 2(a) Plot for the Sodium of Rajrappa Coal Washery**



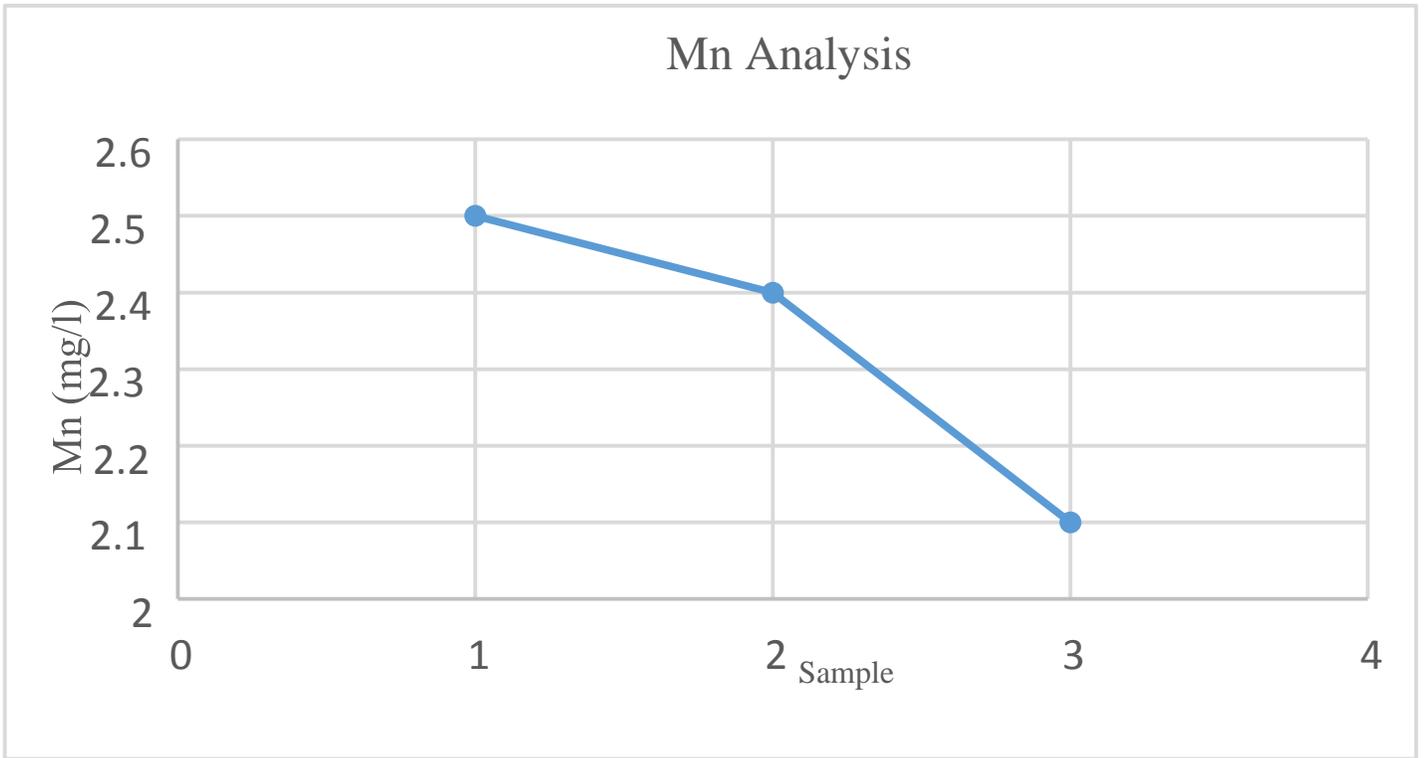
**Fig: 2(b) Plot for the Potassium of Rajrappa Coal Washery**



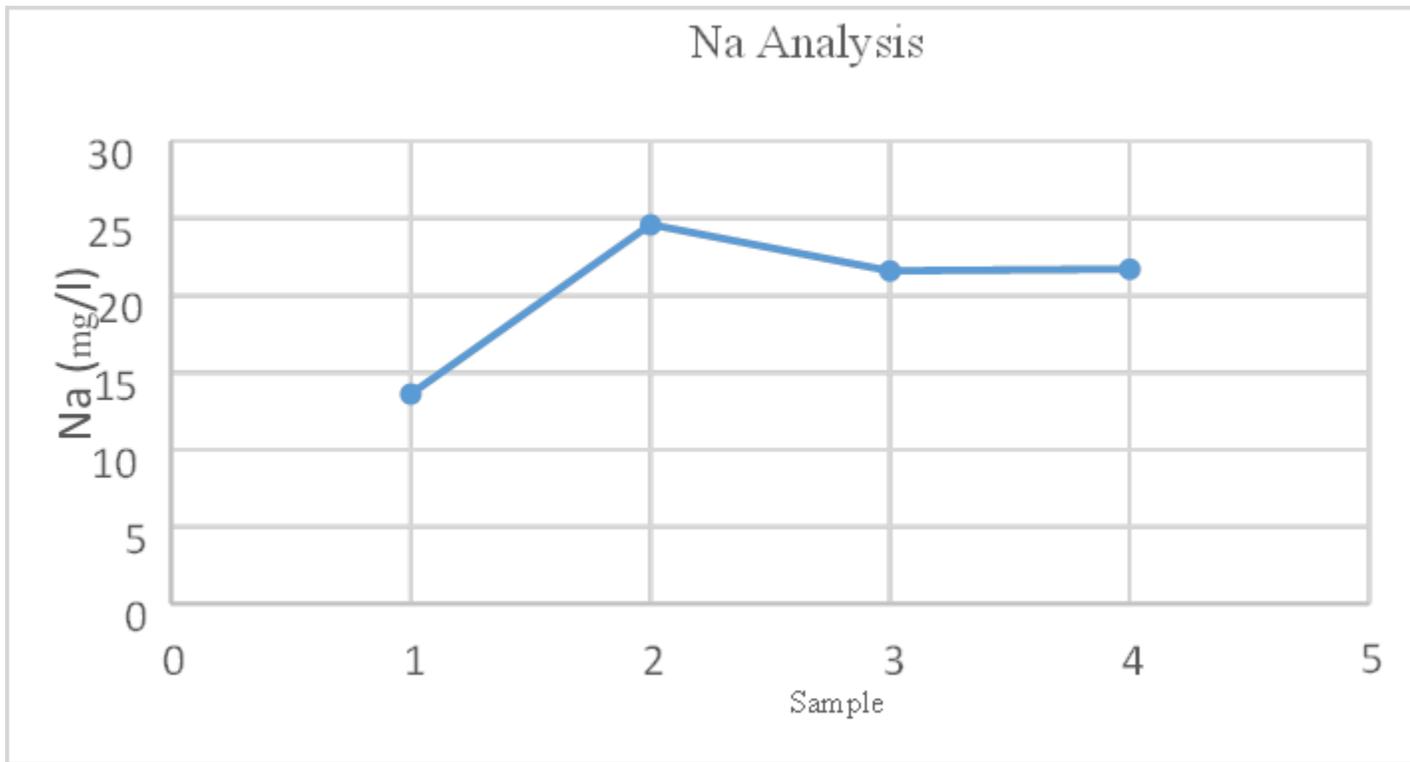
**Fig: 2(c) Plot for the Magnesium of Rajrappa Coal Washery**



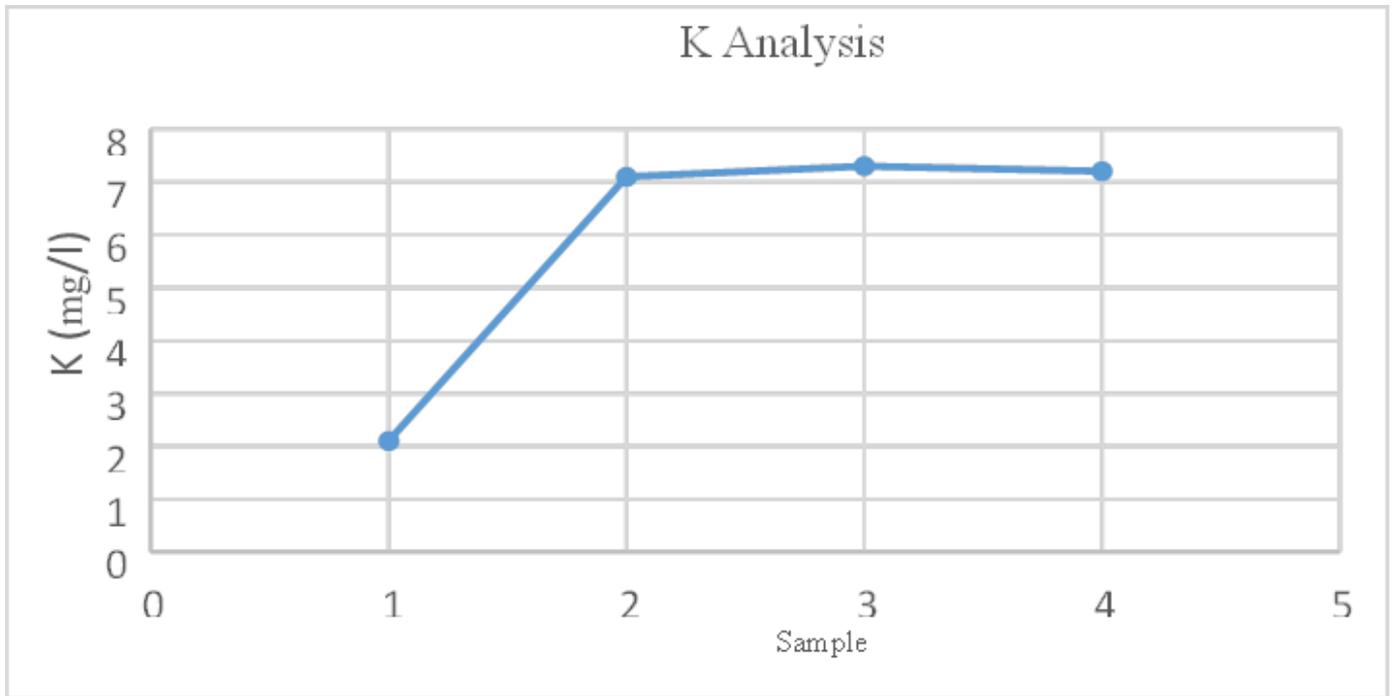
**Fig: 2(d) Plot for the Calcium of Rajrappa Coal Washery**



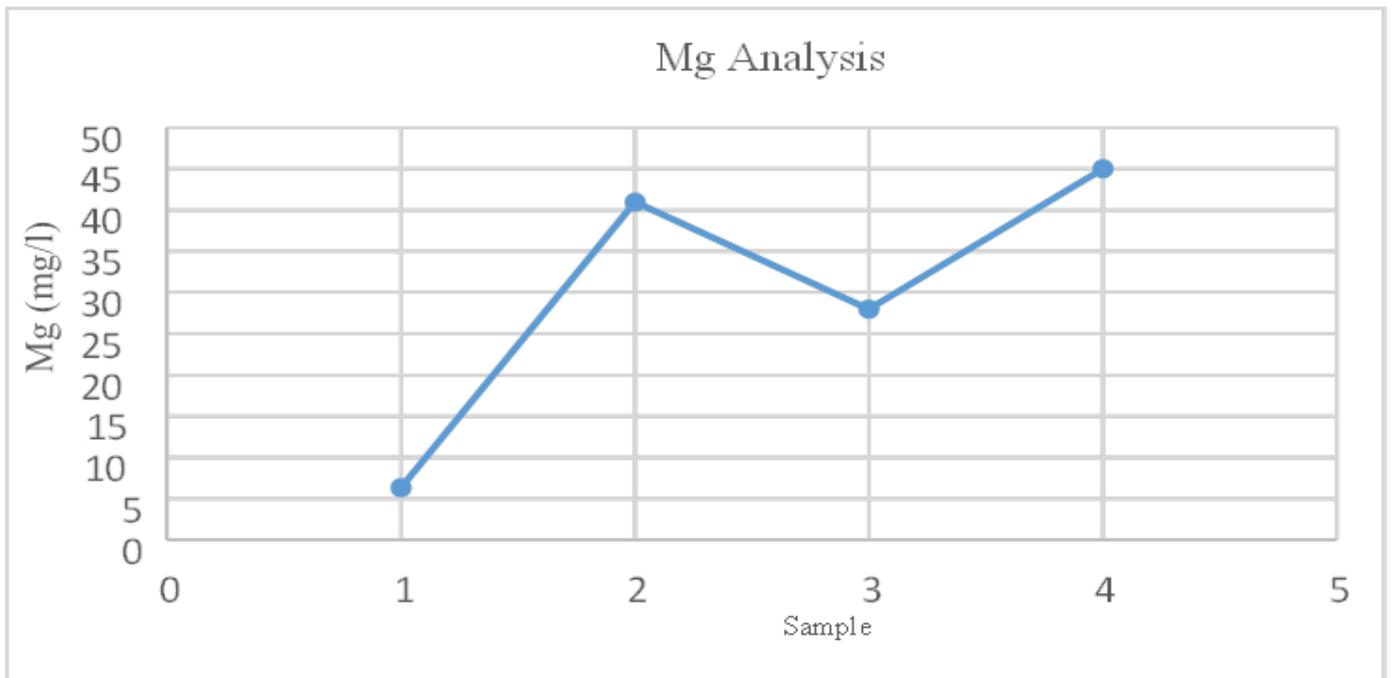
**Fig: 2(e) Plot for the Manganese of Rajrappa Coal Washery**



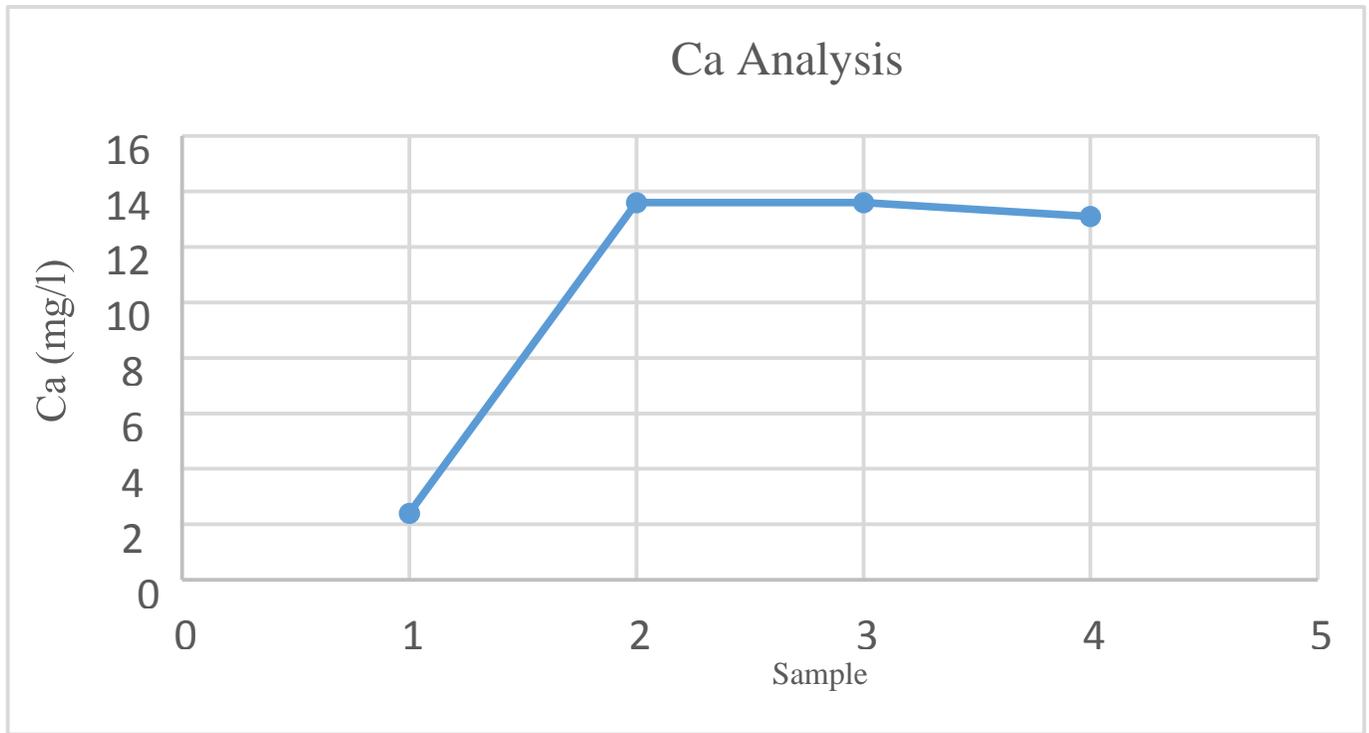
**Fig: 3(a) Plot for the Sodium of Kargali Coal Washery**



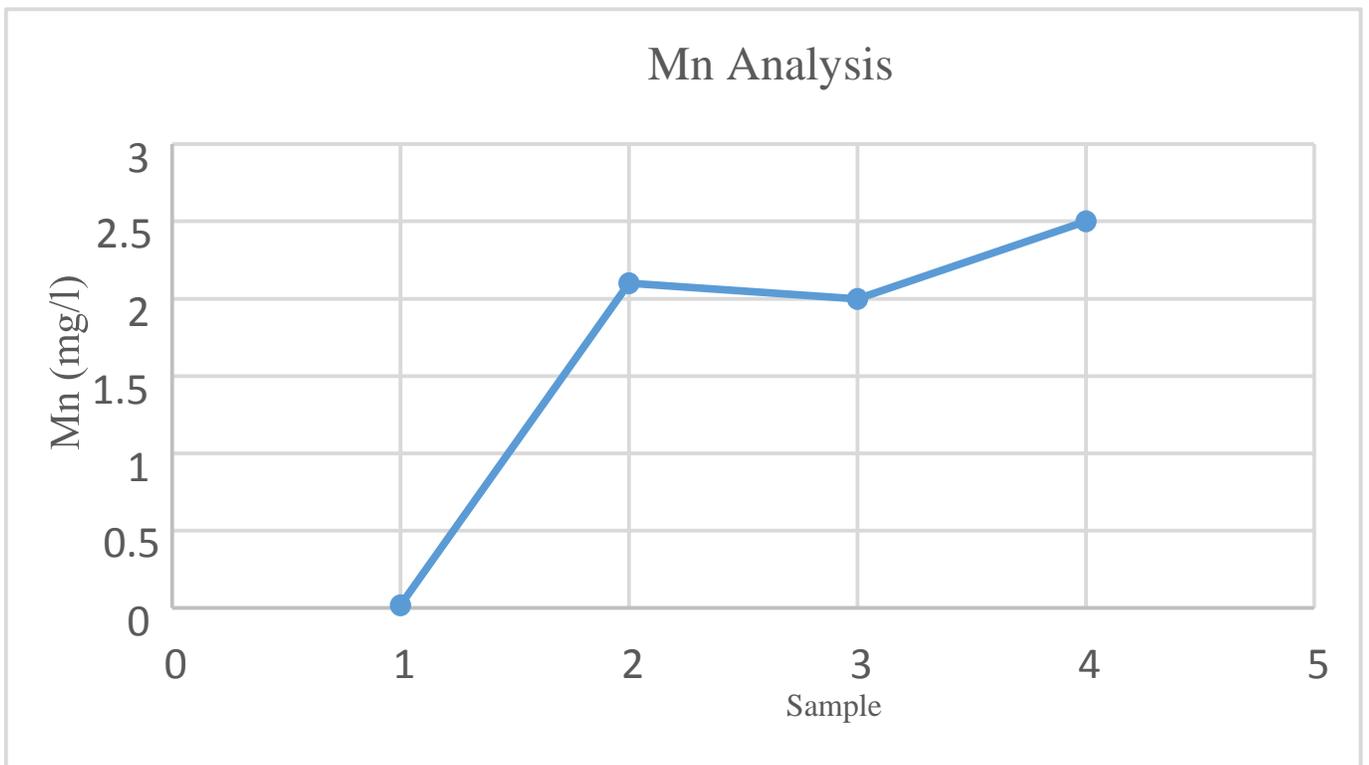
**Fig: 3(b) Plot for the Potassium of Kargali Coal Washery**



**Fig: 3(c) Plot for the Magnesium of Kargali Coal Washery**



**Fig: 3(d) Plot for the Calcium of Kargali Coal Washery**



**Fig: 3(e) Plot for the Manganese of Kargali Coal Washery**

The increment of qualities in the water after beneficiation can be because of salts and minerals exhibit as chlorides and sulfates of the salt that promptly break down in the water.

# **Chapter-5**

## **CONCLUSION**

## 5. CONCLUSION

The decrease of the pH from the raw water intake of the washery to the process water is within the standard limits. MOEF Schedule VI Indian Standard (2006) specifies that it should be within 5.5-9.0.

After the processing of coal is done, the process water contains higher amount of significant components of coal such as Na, K, Mg and Ca in the process water than that of the raw intake water of the washeries. This explains that the complete or the maximum transfer of these components is happening.

Follow components, for example, Ni, Cu, Zn, Cr, Mn and Pb were discovered to exhibit in the water from the beneficiation process, other than Fe (a significant component). The Manganese content is observed to be 2.4 mg/l(fine coal jig), 2.3 mg/l (coarse coal jig), 2.1 mg/l (slurry lake) of the Kedla Coal washery has been exceeded its stipulated limits (2.0 mg/l) according to the MoEF standards which requires dilution while releasing these water outside the washery. The same has occurred in the other two washeries [Rajrappa coal washery 2.1 mg/l (fine coal jig), 2.0 mg/l (coarse coal jig), 2.4 mg/l (slurry lake) and for Kargali coal washery 1.9 mg/l (fine coal jig), 2.4 mg/l (coarse coal jig), 2.8 mg/l (slurry lake)] which has to be taken care for dilution of Mn before releasing the water outside the washery.

So coming across from all the above conclusions we can infer that Mn should be dealt for better decrease of contamination of water followed by the decrease in pH issue. The solids can be evacuated by mechanical dewatering and sedimentation thickeners. For the Manganese issue we can also change the pH of water that is making it more basic from acidic so that the water does not allow to break down of Manganese.

Manganese concentration can also be decreased by oxidation or aeration with chlorine-dioxide, chlorine, ozone, potassium permanganate or lime and lime-soda softening followed by filtration.

And also the elements such as Arsenic, Lead, Cadmium, Iron, Nickel, Copper, Zinc and Chromium are observed to be within the limits in all the three washeries and they can be no harm to the environment or the eco system.

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