Full Length Research Paper

Making high speed diesel and motor gasoline more environmental friendly using *Dalbergia sissoo* wood powder

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The present study aimed at removing chromium (Cr), nickel (Ni) and zinc (Zn) from high speed diesel and motor gasoline samples using wood powder of *Dalbergia sissoo*. Physical parameters of the samples, such as colour, density, specific gravity viscosity, refractive index, specific refractive index, electronic polarizibility, dipole moment and volatile contents were measured using standard methods before and after the removal of the metals to gauge the fuel values of high speed diesel and motor gasoline samples. According to the results obtained, no significant change in the values of high speed diesel and motor gasoline samples was observed, which indicates that the fuel values are unaffected by the decontamination process. Partial digestion method using aqueous nitric acid (HNO_3) solution was used for decontamination. The effects of acid concentration, stirring time and oil to acid ratio, on decontamination were also studied. It was found that 2 M aqueous HNO_3 solution in 1:10 (v/v) oil : acid solution ratio with stirring time of 2 h is sufficient to remove maximum of Cr, Ni and Zn. As regards the effect of pH and time on decontamination, it was found that pH 1 for Cr, Ni and pH 5 for Zn with 45 min stirring time can bring maximum metal to the solution.

Key words: Adsorption, heavy metals, high speed diesel, motor gasoline, *Dalbergia sissoo* wood powder.

INTRODUCTION

Heavy metals cause a serious threat to both man and animals in the environment if not properly reduced to the innocuous level. Environmental pollution by heavy metals that are released into the environment through various human activities is one of the world's major environmental problems. Recovery of heavy metals from industrial waste streams is becoming increasingly important as society realizes the necessity for recycling and conservation of essential metals (Jothinagi and Anbazhagan, 2009). Activated carbon is the most widely used adsorbent due to its excellent adsorption capability for heavy metals. However, the use of these methods is often limited due to the high cost, which makes them unfavorable for the needs of developing countries.

Heavy metals are a large group of trace elements that are both industrially and biologically important. Initially, heavy metals are naturally present in soils as natural components, but now, the presence of heavy metals in the environment has been increased due to human activities. It is a huge problem around the world where excessive concentration of heavy metals such as zinc (Zn), chromium (Cr), nickel (Ni), copper (Cu), cadmium (Cd), mercury (Hg), lead (Pb) and arsenic (As) can be found in fuel samples. Exposure to heavy metals continues although several adverse health effects of heavy metals have been known for a long time. Some of these elements are actually necessary for humans in minute amounts, while others are carcinogenic or toxic, affecting among others, the central nervous system, kidneys, liver skin, bones, or the teeth (nickel, cadmium, zinc, chromium).

It is known that adsorption is one of the most efficient

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methods for the removal of heavy metals from fuel samples. Activated carbon is the most widely used adsorbent due to its excellent adsorption capability for heavy metals. However, the use of this method is often limited due to the high cost, which makes them unfavorable for the needs of developing countries. Many reports have been published on the low-cost adsorbents for heavy metals from aqueous solutions (Akhtar et al., 2008; Akhtar et al., 2009; Babarinde et al., 2008). Meanwhile, the adsorption of heavy metals from aqueous solutions on inexpensive adsorbents has been investigated by many works (Chakravarty et al., 2010; Gadd et al.,, 2009; Gupta and Rastogia, 2008; Kalyani et al., 2010; Kiran and Kaushik, 2008; Nadeem et al., 2009).

In the current study, *Dalbergia sissoo* wood powder was used to remove Cr, Zn and Ni from high speed diesel and motor gasoline samples. The influence of stirring time, pH, and initial concentration of Cr, Zn and Ni was evaluated. Biosorption is emerging as a sustainable effective technology using low cost biosorbent such as bamboo dust (Kannan and Veemraj, 2009), saw dust (Adouby et al., 2007), algae (Lodiero et al., 2006), silk cotton hull (Shanmugavalli et al., 2009), and plant materials (Ali Shafaghat et al., 2012). Biological treatment offers the best environmental friendly method for remediating heavy metal present in fuel samples because it utilizes the capability of the indigenous wood powder. Biological remediation, a process defined as using plants material to remove heavy metals from the environment, is a remediation option that offers green technology solution to the problem of environmental degradation (Perelo, 2010).

MATERIALS AND METHODS

Experimental reagents and apparatus

All the chemicals used, such as ammonia, nitric acid, sulphuric acid, potassium dichromate, zinc chloride, nickel acetate, ethylenediaminetetraacetic acid (EDTA) and ammonium nitrate were of analytical grade of Merk brand. The deionized water of pH 7 was use in the whole experimental work. The equipments used included a shaker (HAAKE SWB 20), balance (Chyo JI-180), refractometer (Bellingham Stanley, A 82302), Kertesz viscometer thermostatic bath (model no. 655), hot plate and stirrer, and Hitachi (model A-1800) atomic absorption spectrophotometer (AAS).

Sampling

Commercially available high-speed diesel and samples were collected randomly in washed and dried plastic bottles from different petrol pumps of different marketing companies in Multan city, Punjab province of Pakistan. The samples taken from each retail outlet was 1 L. The samples were shifted to the laboratory and analyzed.

Washing and storage of glassware

Chromic acid used for washing was prepared by making paste of potassium dichromate in sulphuric acid and diluted using H_2SO_4; few milliliters of chromic acid was added to each container and filled with water. The apparatuses were soaked in chromic acid for 24 h, then washed with tap water several time and finally rinsed with distilled water twice. Subsequently, the apparatuses were stored in dust fumes free atmosphere without touching their inner wall.

Solution preparation

The solutions used were prepared as follows:

(1) 0.0478 g of zinc chloride was dissolved in dilute HNO_3 to make 100 ml solution of 1000 ppm and then it was appropriately diluted using HNO_3 as required.
(2) 0.0177 g of $K_2Cr_2O_7$ was dissolved in dilute HNO_3 to make 100 ml solution of 1000 ppm and then it was appropriately diluted using HNO_3 as required.
(3) 0.0237 g of nickel acetate was dissolved in dilute HNO_3 to make 100 ml solution of 1000 ppm and then it was appropriately diluted using HNO_3 as required.
(4) 37.2240 g of disodium EDTA was dissolved in 100 ml H_2O to make 1 M solution of disodium EDTA.
(5) 04.9 ml of HNO_3 was taken and diluted up to 500 ml in deionized water to make 2.5 M solution.

Pretreatment of filter papers

Whatman no. 42 filter papers were used for filtration purpose and were pretreated by dipping in 0.1 M solution of disodium EDTA for 5 min and then rinsed with distilled water several times until the washing gave negative tests for sodium. These were then dried and stored in a dust free atmosphere.

Physical parameters

Density

The density of the samples was measured using specific gravity bottle. First empty bottle was weighted then it is filled by demonized water and reweighed, then it is dried completely. Specific gravity bottle was filled with samples again weighted; Accuracy of the measurement was ±0.0001 gml^{-1}. The density was calculated by using formula at 19°C:

$$Density = \frac{Weight\ of\ sample}{Weight\ of\ water} \times Density\ of\ water\ at\ 19°C$$

Specific gravity

The specific gravity was calculated from density using the following formula; density of water is at 19°C.

$$Specific\ gravity = \frac{Density\ of\ sample}{Density\ of\ water}$$

Viscosity

Viscosity of samples was determined by viscometric method at 19°C. A well washed and dried viscometer was taken and filled it

(20 ml) with distilled water. Flow time of water between the two marks was noted. Viscosity was calculated by the following formula; accuracy of the measurement is ± 0.01 cp.

$$\eta = \frac{T s d s}{T w d w} \times \eta w$$

Where η is the viscosity; Tw and T_s are the time flow of water and samples respectively, d_s and d_w are densities of water and samples at room temperature and η_w is the viscosity of water.

Refractive Index

First, the refractometer was rinsed with acetone at temperature of 19°C. It was calibrated by measuring the refractive index of water, which was 1.333 and subsequently refractive index of the samples was measured by placing few drops of the samples on slide. The reading was noted and subsequently rinsed with acetone and alcohol before reuse. Specific refractive index was calculated using the following formula:

$$Rs = \frac{n^2 - 1}{n^2 + 2} \times \frac{1}{d}$$

Where, Rs is the specific refractive index and d is the density. Furthermore, the electronic polarizibility was calculated following formula:

$$\alpha = \frac{3Rs}{4 \Pi In}$$

Dipole moment was calculated by using following formula:

$$P_D = \frac{4}{3\pi N \alpha}$$

Volatile and non-volatile contents

First, a clean Petri dish was weighed and then 1 ml of sample was taken in the Petri dish and weighed immediately. Next, the sample was allowed to evaporate in air until the no loss in weight was noted; the percentage of volatile and non volatile contents was calculated by the formula:

$$\text{Percentage of non-volatile contents} = \frac{\text{Weight of solid}}{\text{Weight of sample}} \times 100$$

Percentage of volatile contents = 100 – Percentage of non-volatile contents

Digestion

Digestion of sample was done by taking known volume of sample, known volume and concentration of nitric acid solution was taken in well stoppered flask and stirred for 2 h using shaker at room temperature. Water and sample layers were allowed to separate and then water layer was separated with the help of pipette and sucker. Metal contents in water were analyzed by flame atomic absorption spectrometric (FAAS).

Factors affecting digestion

Stirring time

The effect of stirring time on digestion using fixed amount of sample and 3 M (20ml) nitric acid solution was studied by varying stirring time. The time was varied from 1 h to over night with an interval of 2 h. Digestion was completed after 2 h and then analyzed by FAAS.

Concentration of acid

Effect of acid concentration on digestion was studied using 1, 2 and 3 M (20 ml) nitric acid solutions for 2 h. At lower concentration of acid, digestion was incomplete. Inefficient digestion was confirmed by FAAS (Table 1). Digestion of sample was completed using 3 M (20 ml) nitric acid solutions at duration of 2 h.

Sample to acid ratio

Different ratios of sample and 2 M nitric acid solution were used to check their effect on digestion. Sample and 2 M nitric acid having ratios 1:1 and 1:10 were used to optimize the ratio. The presence of metals was monitored by FAAS at 1:10 of sample to acid and stirring for 2 h. All the metals were analyzed by FAAS. From these studies, the optimum conditions for digestions were 2 M HNO_3 stirred in the ratio of 1:10 for sample to acid solution for 2 h at room temperature.

Adsorption

Pretreatment of D. sissoo wood powder

D. sissoo wood powder was washed with tap water many times until transparent media appeared, then it was washed with deionized water dipped in 0.1 M HNO_3 for 2 h. It was again washed with deionized water and filtered with filter paper. Afterward, it was dried in oven and finely ground powder was sieved and preserved in dust free atmosphere.

General procedure

Briefly, 20 ml of 5 ppm standard metal ion solution maintained at specific pH (pH varying from 1 - 7), was shaken with 0.2000 g of pretreated D. sissoo wood powder at 19°C for different time intervals (time varying from 15 - 60 min). The wood powder was removed by filtration using pretreated filter paper. Finally, the filtrate was analyzed by FAAS using standard instrumental conditions (Table 2). Blank sample was also prepared in the same manner.

Effect of pH on adsorption

Adsorption was carried out at a pH range of 1 - 7. Ni and Cr gave best result at pH 1, while that of Zn was at pH 5. The pH was maintained by adding NH_4OH solution drop wise and checked with pH paper by matching with standard coloured strip.

Effect of shaking time on adsorption

Shaking time varied at intervals of 15, 20, 30, 45, and 60 min to check the effect of time on adsorption. Adsorption of metal was completed in 45 min D. sissoo wood powder, which was confirmed by FAAS.

Table 1. Calculation modes for the determination of Cr, Ni and Zn by FAAS.

Elements	Cr	Ni	Zn
Measurement mode	A.A.S (conc.)	A.A.S (conc.)	A.A.S (conc.)
Signal mode	Integration	Integration	Integration
Calculation time	1 s	1 s	1 s
Delay time	1 s	1 s	1 s
No. of replicate	2	2	2
Statistics	Mean, SD, RSD	Mean, SD, RSD	Mean, SD, RSD
Sample blank	No	No	No
Unit	ppm	ppm	ppm

Table 2. Instrumental conditions for the determination of Cr, Ni and Zn by FAAS.

Elements	Cr	Ni	Zn
Lamp current	7.5 mA	10.0 mA	7.5 mA
Wave length	357.5 nm	332.0 nm	324.0 nm
Slit width	1.3 nm	0.2 nm	1.3 nm
Atomizer	STD burner	STD burner	STD burner
Oxidant	Air	Air	Air
Oxidant pressure	1.6 kg/cm^2	1.6 kg/cm^2	1.6 kg/cm^2
Fuel	C_2H_2	C_2H_2	C_2H_2
Fuel pressure	0.40 kg/cm^2	0.30 kg/cm^2	0.03 kg/cm^2
Burner height	7.5mm	2.2 mm	7.5 mm
HCL Gain	80	80	80

Statistical parameters of calibration curve

Calibration curves were obtained for metals (Zn, Ni, and Cr) using standard solution contaminating 1% nitric acid. Correlation co-efficient of each calibration curve was well above 0.990, which is an indication of best fit between standard concentration and respective absorbance values.

RESULTS AND DISCUSSION

Physical parameters

Physical parameters such as colour, density, specific gravity, viscosity, refractive index, specific refractive index, electronic polarizibility, dipole moment and volatile contents were measured using standards as earlier described. The values are listed in Tables 3 and 4. These physical parameters were also measured after removing the metal. No significant change in the values was observed, which indicated that the digestion method did not affect the physical parameters. Hence, the fuel value for further confirmation, ignition and flash point employed indicated the retention of fuel value after digestion.

Digestion

In the literature, many methods are present to analyze the metal contents of commercial and crude oil samples. These methods have their own limitations; sometimes they require total decomposition of sample under controlled conditions, total digestion of sample under highly reactive atmosphere and direct ignition of the sample etc. Moreover, in these methods, it is not possible to recycle this contaminated oil. However, decontaminating (Nasir et al., 2007) the oil is important in order to control toxicity generated by the fuel ignition. Hence we aimed at decontaminating by partial digestion to minimize the pollution and maximize the fuel value. Many methods have been reported in the literature ((Ofomaja et al., 2010). For digestion, we selected the use of nitric acid for decontamination. Many parameters such as acid concentration (pH) decontamination time, ratio of oil to acid solution, have been investigated to optimize the parameters and to maximize the removal of metals from oil (Resmi et al., 2010).

Factors affecting digestion

Acid concentration

Acid concentration varied from 1 - 3 M (oil to acid ratio1:1 and stirring time 1:00 h). It was observed that the decontamination of metals occurred more quickly in highly acidic media. The decontamination process was followed by FAAS. We found that 2 M nitric acid in H_2O is sufficient to decontaminate the Cr, Ni and Zn from samples. Results are shown in Figure 1.

Table 3. Physical parameters of motor gasoline before and after adsorption of heavy metals.

Sample	Motor Gasoline 1	Motor Gasoline 2	Motor Gasoline 3	Range	Mean	SD
Colour	Pink	Pink	Pink	0.00 - 0.00	Pink	0.0000
Density (g/cm^3)	0.7890	0.7787	0.7922	0.7787 - 0.7922	0.7866	0.0071
Specific Gravity	0.7960	0.7856	0.7992	0.7856 - 0.7922	0.7936	0.0071
Viscosity (cp)	0.47	0.47	0.49	0.47 - 0.49	0.4767	0.0116
Refractive Index	1.616	1.613	1.618	1.613 - 1.618	1.6157	0.0025
Specific Refractive Index (cm^3/g)	0.455	0.441	0.451	0.441 - 0.455	0.4490	0.0072
Electronic Polarizibility (ml)	1.8037×10^{-25}	1.7482×10^{-25}	1.8037×10^{-25}	$(1.7482 - 1.8037) \times 10^{-25}$	1.7852×10^{-25}	0.0320
Dipole Moment (D)	0.455	0.441	0.451	0.441 - 0.455	0.449	0.0072
Volatile Contents (%)	99.00	98.00	97.00	97.00 - 99.00	98.00	1.0000

Table 4. Physical parameters of high speed diesel oil before and after adsorption of heavy metals.

Sample	HSD 1	HSD 2	HSD 3	Range	Mean	SD
Colour	Brown	Brown	Brown	0.00-0.00	Brown	0.0000
Density (g/cm^3)	0.8872	0.8775	0.8644	0.8644 - 0.8872	0.8764	0.0114
Specific Gravity	0.8950	0.8852	0.8720	0.8720 - 0.8950	0.8841	0.0115
Viscosity (cp)	5.00	4.85	4.84	4.84 - 5.00	4.8967	0.0896
Refractive Index	1.476	1.471	1.475	1.471 - 1.476	1.4740	0.0027
Specific Refractive Index (cm^3/g)	0.323	0.325	0.326	0.323 - 0.326	0.3245	0.0015
Electronic Polarizibility (ml)	1.2828×10^{-25}	1.2923×10^{-25}	1.2929×10^{-25}	$(1.2828 - 1.2929) \times 10^{-25}$	1.2893×10^{-25}	0.0057
Dipole Moment (D)	0.323	0.325	0.326	0.323 - 0.326	0.3247	0.0015
Volatile Contents (vol. %)	15.00	14.00	14.00	14.00 - 15.00	14.3333	0.5774

Stirring time

In brief, 2 M aqueous HNO_3 solution and sample (ratio 1:1) were stirred at room temperature; time interval varied from 1:00 h to over night with an interval of 1:00 hour. It was observed that decontamination occurred in 2 h and afterwards, the metal contents tend to diffuse back to the oil. This was because of the establishment of the reverse equilibrium of metal flow from acid (high cone) to oil (lower cone). Therefore, we resolved that 2 h and stirring time using 2 M aqueous HNO_3 is sufficient for decontamination. Results are shown in Figure 2.

Oil to acid ratio

Oil to acid ratio varied to ascertain the effect on decontamination of metals. The ratio varied from 1:1 (v/v) to oil: aqueous HNO_3 acid solution. It was found that if we increased the ratio of the oil to acid, decontamination becomes quicker for maximum decontamination. The results were followed by FAAS. Lower ratio of oil to acid look longer time and gave insufficient results, while higher ratio was the optimum condition for denomination.

Results are shown in Table 5.

Adsorption

Adsorption (Rafika et al., 2009; Kadirvelu et al., 2001) technique is being widely used for exchange purpose in many aspects of decontamination, pre-concentration (Nakbanpote et al., 2000) or removal of ions. The use of many adsorbing material such as bauxite, zeolite, charcoal, xerogels and other ion exchangers are in common practice. The choice of adsorbent depends on the situation.

In general, commercial availability, price, chemical resistance and life etc., are among the factors affecting the selection of the substance. In this study, we aimed at using low cost (Nhapiet al., 2011; Egila et al., 2011), commercial available and more practical material for adsorption and decontamination. *D. sissoo* (Dhir et al., 2010) wood powder in the solution adsorption is the ash contents and wood.

We studied the effect of few parameters to optimize the conditions for maximum decontamination of chromium, nickel and zinc.
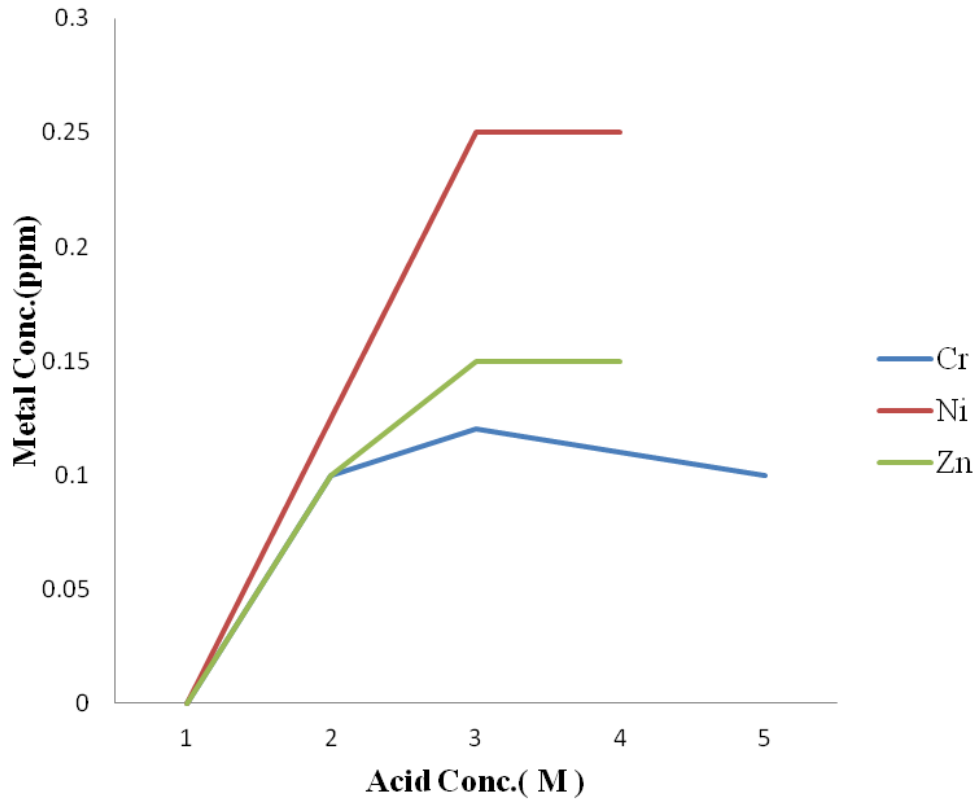
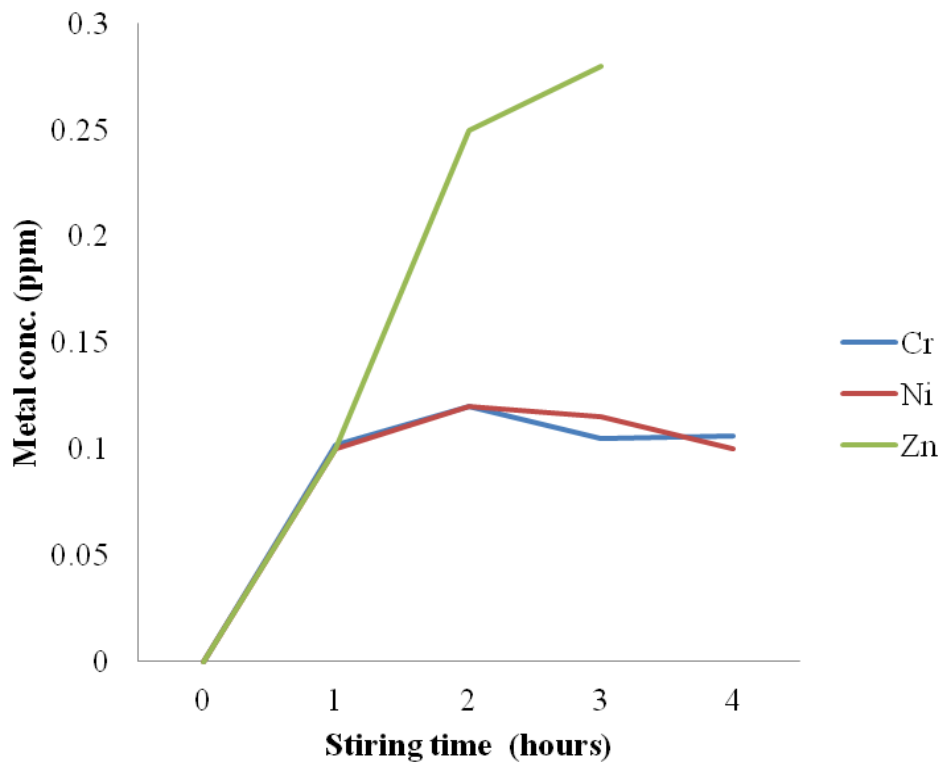**Figure 1.** Effect of acid concentration on the digestion of Cr, Ni and Zn.

Figure 2. Effect of stirring time on digestion of Cr, Ni and Zn.

Table 5. Effect of oil to acid ratio on digestion.

Oil to acid ratio	Metal concentration (ppm)		
	Cr	Ni	Zn
1:1	0.12	0.10	0.23
1:10	0.20	0.19	0.45

Table 6. Decontamination of chromium from motor gasoline samples.

Samples	Concentration before adsorption (ppm)	Concentration after adsorption (ppm)	Percentage adsorbed (%)
Motor Gasoline 1	0.10	0.01	90.00
Motor Gasoline 2	0.12	0.01	91.66
Motor Gasoline 3	0.05	0.009	82.00

Table 7. Decontamination of chromium from high speed diesel.

Samples	Concentration before adsorption (ppm)	Concentration after adsorption (ppm)	Percentage adsorbed (%)
HSD 1	0.12	0.01	91.66
HSD 2	0.20	0.02	90.00
HSD 3	2.53	0.50	80.23

Factors affecting adsorption

The pH of the media strongly affects the adsorption process. We varied the pH from 1 - 7 to gauge the adsorption of zinc, nickel and chromium on solid surface using standard solution of commercially available metals salts. It was seen that the adsorption of metal ions on wood increased as the pH of the media decreased. The maximum absorption of nickel and chromium occurred at pH 1, while the maximum adsorption of zinc was observed at pH 5. Results are shown in Figure 3.

Shaking time

Shaking time was varied of 15, 20, 30, 45 and 60 min at pH 1 for Ni and Cr, and pH 5 for Zn using standard conditions. It was observed that the complete removal of the metals occurred in 45 min. Subsequent stirring of the metal solution with wood does not improve the adsorption of the metal. The aforementioned experiments were performed initially using standard metal solution of concentrations of 5.00, 6.00, 7.00 and 8.00 ppm. The results are shown in Figure 4.

Moreover, the results of the metal removal are listed in Tables 6 to 11. These results indicated the efficacy of the digestion techniques used to remove the metals. They also highlight the role of *D. sissoo* wood powder in the removal of Cr, Ni and Zn. Cr, Ni and Zn are present in *D. sissoo* wood powder along with sodium (Na), potassium (K), magnesium (Mg), strontium (Sr), and barium (Ba) in trace amount, and their contents vary from 0.01 ppm to 0.08 ppm. The results in the Tables 6 and 7 indicated that the removal of Cr from motor gasoline sample was 82 - 90% and from high speed diesel it was 80.23 - 91.66%. The removal of Ni from motor gasoline sample was 91.66 - 100% and from high speed diesel is 80.00 - 83.33% under optimum conditions (Tables 8 and 9). Also, the removal of Zn from motor gasoline sample was 60.00 - 73.86% and from high speed diesel it was 52.38 - 54.54% under optimum conditions (Tables 10 and 11). These results indicate that Cr and Ni could be removed efficiently using *D. sissoo* wood powder as compared to Zn.

Health hazards of Cr, Ni and Zn

Chromium (VI) compounds are toxins and known human carcinogens, whereas chromium (III) is an essential nutrient. Breathing in high levels can cause irritation to the lining of the nose, nose ulcers, runny nose, and breathing problems, such as asthma, cough, shortness of breath, or wheezing. Nickel causes allergies, dermatitis, eczema, headaches, dizziness and lack of sleep. Zinc causes stomach cramps, nausea, vomiting, anemia,
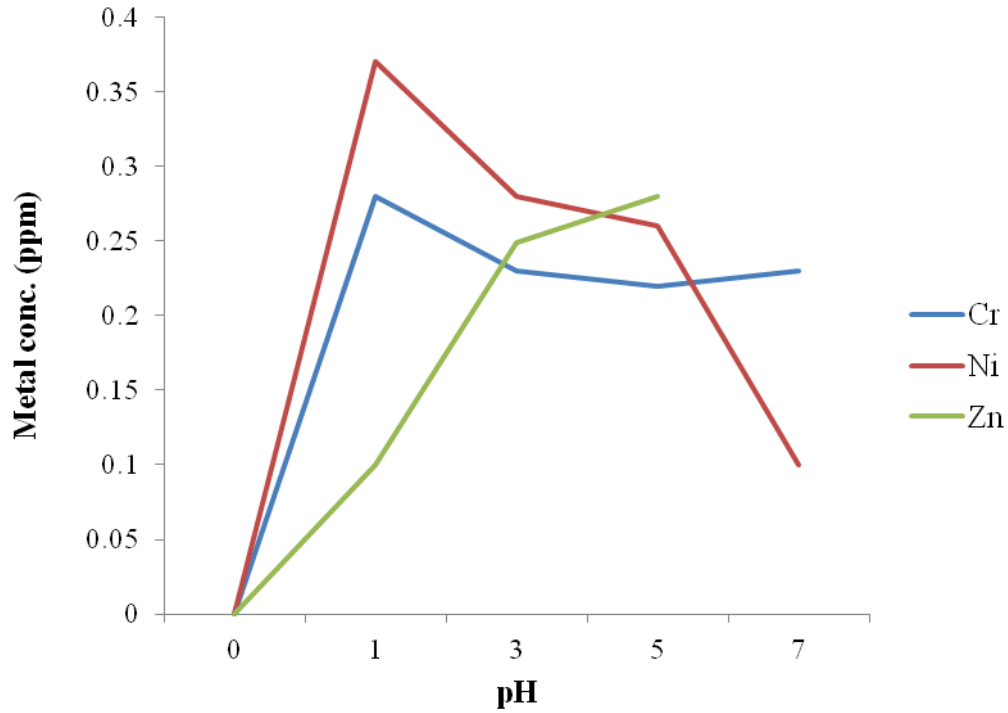
Figure 3. Effect of pH on adsorption of Cr, Ni and Zn by wood from standards.
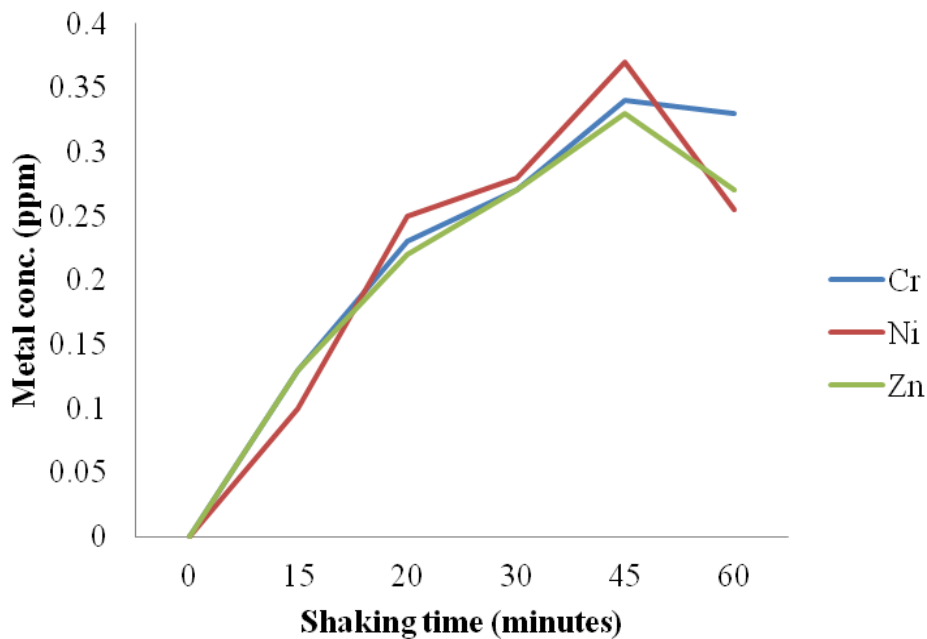

Figure 4. Effect of shaking time on the adsorption of Cr, Ni and Zn.

damage to the pancreas, cerebral edema with nausea, vomiting, dizziness, visual disorders, cramps, forgetfulness, fatigue, lack of interest, headaches, and sleeping difficulties.

Conclusion

Based on the present study, it could be concluded that some low cost materials like *D. sissoo* wood powder can

Table 8. Decontamination of nickel from motor gasoline samples.

Samples	Concentration before adsorption (ppm)	Concentration after adsorption (ppm)	Percentage adsorbed (%)
Motor Gasoline 1	0.10	0.10	100.00
Motor Gasoline 2	0.12	0.01	91.66
Motor Gasoline 3	0.12	0.01	91.66

Table 9. Decontamination of nickel from high speed diesel.

Samples	Concentration before adsorption (ppm)	Concentration after adsorption (ppm)	Percentage adsorbed (%)
HSD 1	0.12	0.02	83.33
HSD 2	0.17	0.03	82.35
HSD 3	0.70	0.14	80.00

Table 10. Decontamination of zinc from motor gasoline samples.

Samples	Concentration before adsorption (ppm)	Concentration after adsorption (ppm)	Percentage adsorbed (%)
Motor Gasoline 1	0.88	0.23	73.86
Motor Gasoline 2	0.50	0.20	60.00
Motor Gasoline 3	0.33	0.11	66.66

Table 11. Decontamination of zinc from high speed diesel.

Samples	Concentration before adsorption (ppm)	Concentration after adsorption (ppm)	Percentage adsorbed (%)
HSD 1	0.22	0.10	54.54
HSD 2	0.42	0.20	52.38
HSD 3	0.45	0.21	53.33

be used efficiently in the removal of heavy metal (Cr, Ni and Zn) from aqueous solutions. The removal of heavy metal ions was pH-dependent as the adsorption capacity increased with increasing the pH of the solution, and at a particular pH the order of increasing the removal percentage was Ni > Cr > Zn . The metal ions showed different behaviors towards adsorption on *D. sissoo* wood powder by increasing the initial concentration of the metal ions. This study showed *D. sissoo* wood powder to be a suitable adsorbent for removing Cr, Ni and Zn heavy metal ions. The physical properties of the high speed diesel and motor gasoline did not change after the adsorption, indicating that the decontamination process does not affect the fuel value. In addition, it is a low cost and less hazardous method. Moreover, the decontamination procedure is more efficient for Cr and Ni than Zn. *D. sissoo* wood powder with a suitable binder can be used in petroleum refineries and petroleum depot for the removal of Cr, Ni and Zn to make high speed diesel and motor gasoline environmental friendly by maintaining experimental conditions.

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