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Research Article

The Predisposition of Iraqi Rice Husk to Remove Heavy Metals from Aqueous Solutions and Capitalized from Waste Residue

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Abstract: This study is deal with study the potential of Iraqi Rice Husk (IRH) on the removal of three heavy metals pollutant which were (Mg, Mn and Mo) ions from industrial wastewater using different design parameters by adsorption process. Results show that the removal efficiency were (93.95, 97.18 and 95.26) % for heavy metal (Mg, Mn and Mo) respectively from aquatic solution decreased with increasing of initial concentration and flow rate while the removal efficiency increased with increasing absorbance material bed height, pH and feeding temperature. Statistical model is achieved to find an expression relates the overall operating parameters with the removal efficiency for each metal ions used in this investigation in a general equation (each one alone). The samples of (IRH) remaining after using it in the removal of (Mg, Mn and Mo) heavy metal ions above from Simulated Synthetic Aqueous Solutions (SSAS) to investigate the capitalized of it in different methods. Different benefits possess which are: remove the three toxic heavy metals ions contaminated the water, get rid of agricultural waste (IRH), in the same time, produce light and more benefit hydrocarbons from n-heptane isomerization using a type Y-zeolite catalyst synthesis from remaining (IRH) and prepare a cheap and active rodenticide.

Keywords: Aqueous solution and wastewater, catalyst, heavy metal, residue, rice husk, type-Y zeolite

INTRODUCTION

The greater environmental awareness in both the public and regulatory sphere in recent year has necessitated greater treatment of industrial effluent (Townsed, 2001). The interest has been increased in recent years over the discharge of pollutants from industrial wastewater to reach the standard values of these pollutants before their discharge to the aquatic system (like river) or to the sewer network. In the field of environmental pollution, there are few subjects that, during the latest years, have developed as rapidly as the study of toxic metals (Bhattacharya and Venkobachar, 1984). According to the World Health Organization (WHO), the metals of most immediate concern are Al, Cr, Mn, Fe, Co, Ni, Cu, Zn, Cd, Hg and Pb (Baig *et al*., 2005). It is apparent that the presence of a toxic metal may not represent a hazard if a threshold exists below which there are no observable effects. It should be noted that certain heavy metals, including Al, Cu, Cd, Fe, Pb, Mn and Ni are essential or beneficial or harmful in trace quantities (Kirk and Laster, 1984). The toxicity of a given heavy metal depends on the total amount ingested, pH of treated water as well as a number of factors (Kasim, 1990). Heavy metal ions can came from many sources like industrial and municipal wastewater in the absence of the affective treatment, urban runoff, rain water and agricultural fertilizer may be the most important sources of heavy metals in aquatic environment. A large number of different industries produce effluents contaminated with heavy metal ions. Industries such as minerals and metallurgical processing, leather, textile, chemical manufacture, metal finishing and many other industries produce heavy metals in aqueous solution as waste (Townsed, 2001). In this study the adsorption of heavy metals which are (Mg, Mn and Mo) using IRH was tested and endeavour of capitalizing from the residue in a convenient, economical way and ecofriendly.

EXPRIMENTAL WORK

Iraqi rice husk (adsorbent media): IRH was collected from Al-Shanafia fields for rice in the Southern of Iraq. The rice husk was washed three times with doubled distilled water. Excess distilled water was used to remove the soluble materials present in the rice husk bringing from the field, boiled to remove colour and other fine impurities may be found in the rice husk and then dried at 105°C for 24 h and the adsorbent thus processed was used in its original piece size. The surface area of IRH was measured by BET (Brunauer-Emmett-Teller nitrogen adsorption technique). Characteristics of IRH were presented in Table 1. When

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Table 1: Characterization properties of Iraqi rice husk

Chemical Composition	
Compound	Composition wt %
SiO_2	90.7
Al_2O_3	0.13
Fe_2O_3	0.06
TiO_2	0.015
CaO	0.61
MgO	0.25
Na_2O	0.09
K_2O	2.64
P_2O_5	0.73
LOI	4.71
S.A (m^2/g)	57.5

Table 2: Heavy metals and it's salts uses

Heavy metal	Salt of heavy metal uses
Mg	$MgCl_2.6H_2O$
Mn	$MnCl_2.4H_2O$
Mo	$MoCl_3$

Table 3: Experimental results of final percent removal of heavy metals after reusability of Iraqi rice husk

Heavy metal	Final percent removal reached after reuses %	Times of repeated uses
Mg	2.35	15
Mn	5.25	10
Mo	4.55	12

the IRH was heated at 105°C in an oven, most of the water had been removed from the rice husk while the second major mass loss of about 45-65% was attributed to the breakdown of cellulose constituent char, which is a carbonaceous residue.

Stock solutions: In order to avoid interference with other elements in wastewater, the experiments in this study were carried out using SSAS of different heavy metals. 1000 mg/L stock solution of each heavy metal ion was prepared by dissolving known weight of each heavy metal salt in one liter of double distilled water as shown in Table 2. All solutions using in the experiments were prepared by diluting the stock solution with double distilled water to the desired concentrations for the experimental work of this investigation. The heavy metal ion concentrations were measured using spectrophotometer thermo-genesys 10 UV, USA.

Sorption unit: Fixed bed column of continuous mode experiments were conducted in order to test the heavy metal (Mg, Mn and Mo) ions removal by treated SSAS of above heavy metals each one alone at desired concentration with the various bed heights of the adsorbent media (IRH) using different flow rates of SSAS of heavy metals at various pH. The pH value was adjusted using 0.1 N NaOH and 0.1 N HCl solutions. The sorption unit consists of two glass container of SSAS of heavy metal ions one for inlet and another for outlet each of (1 L) capacity. Glass column has 2.54 cm ID and 100 cm height with flow direction is downward by gravity. The sorption column packed with adsorbent media to a height of (10, 20, 30, 40, 50, 60 and 70 cm) supported from the top and the bottom by glass hollow cylinder layer, each cylinder have (0.5 cm ID, 0.1 cm thickness and 1 cm long).

Before starting the runs, the packed bed sorption column was rinsed by double distilled water down flow through the column. The IRH is packed in the column to the desired depth and fed to it as slurry by mixing the media (IRH) with distilled water in order to avoid the formation of air bubbles inside the media. After the packed bed sorption column was accommodation and putting the required amount of adsorbent media, the adsorption process started by allowing the heavy metal SSAS of required concentration and pH down flow through the sorption column from inlet container by gravity at a precise flow rate in experiment which is adjusted by the valve.

To determination the best operational conditions, the experiments were carried out at a temperature between (20-55°C), various pH values which are (1-8) and initial feed concentrations of SSAS of different heavy metal ions which are between (1-100) mg/L each one alone and at different flow rates which are between (5-100) mL/min for each heavy metal initial feed concentration. Outlet samples after treatment in each experiment were collected every 10 min from the bottom of packed column and the unadsorbed concentration of heavy metal ion in aqueous solution was analyzed by spectrophotometer.

Reusability of Iraqi rice husk*:* In order to check the reusability of sorbent media, treated IRH with different heavy metal was firstly dried at 105°C after that tested again in sorption unit at the conditions of experiment gives the best percent removal of heavy metal ions each one alone from aqueous solution as shown in Table 3. The capacity of the sorbent was found to be decreased until be constant at destined percent removal after different times repeated use. The destined percent removal and number of repeated uses were dependent on heavy metal; thus multiple use of sorbent was seen to be feasible.

RESULTS AND DISCUSSION

The ability of IRH to remove heavy metal ions from SSAS in fixed bed column of continuous mode at various parameters which are pHs of SSAS of heavy metal ion (*pH*), height bed of adsorbent media (IRH) (*h*), flow rates of SSAS (*F*), SSAS temperature (T_{feed})

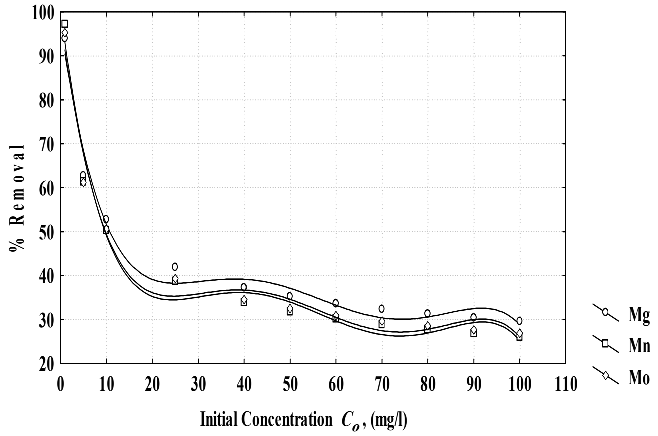

Fig. 1: Effect of initial concentration (C_o) on the percent removal of different heavy metal ions Tf = 45°C, hb = 0.7 m, t = 60 min. and F = 5 mL/min.

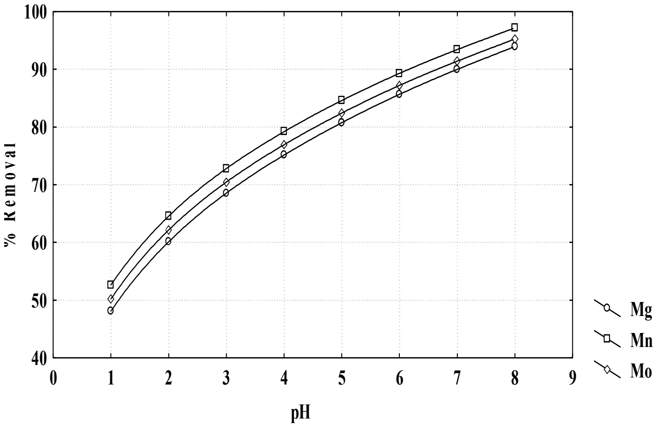

Fig. 2: Effect of *pH* on the percent removal of different heavy metal ions C_o = 5 mg/L, Tf = 45°C, hb = 0.7 m, t = 60 min. and F = 5 mL/min

and time of treatment (*t*) was investigated. The experiments were achieved by varying all above parameters for different initial concentrations (C_0) of SSAS of heavy metal (each one alone). Thus, the results obtained are explained below.

Effect of initial concentration: The results showed that using adsorbent material, the percent removal of heavy metal ions (each one alone) was decreased when the initial concentration (C_0) of SSAS of heavy metal ions was increased at constant other variables as shown in Fig. 1. This can be explained by the fact that the initial concentration of heavy metal ions had a restricted effect on heavy metal ions removal capacity; simultaneously the adsorbent media had a limited number of active sites, which would have become saturated at a certain concentration. This was lead to the increase in the number of heavy metal ion molecules competing for the available functions groups on the surface of adsorbent material. Since the solution of lower concentration has a small amount of heavy metal ions than the solution of higher concentration of it, so the percent removal was decreased with increasing initial concentration of heavy metal ions. For adsorbent media, higher percent removal were (93.95, 97.18 and 95.26) % for heavy metal (Mg, Mn and Mo) respectively, at initial heavy metal ion concentration of 5 mg/L, so adsorbent material was found to be efficient to heavy metal ions removal from SSAS and wastewater.

Effect of pH: The results showed that using adsorbent material, the percent removal of heavy metals (Mg, Mn and Mo) ions (each one alone) was increased when the pH of SSAS of above heavy metal ions was increased at constant other variables as shown in Fig. 2.

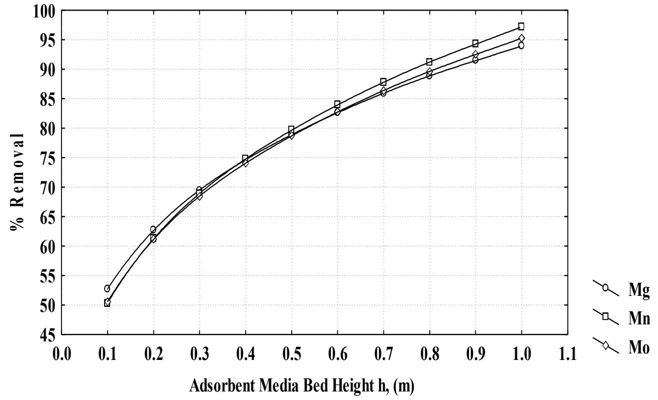

Fig. 3: Effect of adsorbent media bed height (hb) on the percent removal of different heavy metal ions $C_{\circ}$ = 5 mg/L, Tf = 55°C, t = 60 min. and F = 5 mL/min

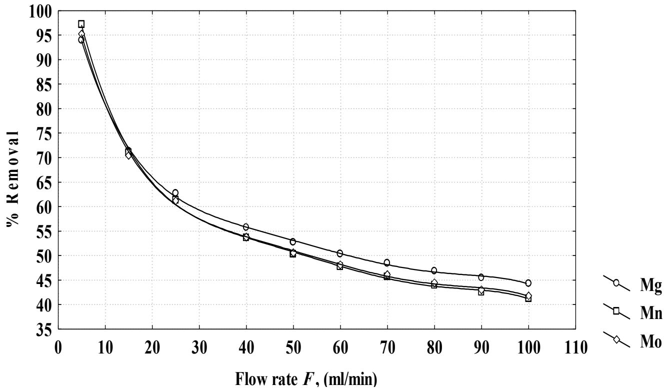

Fig. 4: Effect of aqueous solution flow rate (F) on the percent removal of different heavy metal ions $C_{\circ}$ = 5 mg/L, T_f = 45°C, h_b = 0.7 m and t = 60 min

It is well recognized that the pH of the aqueous solution is an important parameter in affecting adsorption of heavy metal ions (Cayllahua and Torem, 2010). The adsorption of heavy metal (Mg, Mn and Mo) ions (each one alone) can be explained by ion-exchange mechanism of sorption in which the important role is played by functional groups that have cation exchange properties.

For this case at lower pH values, metals removal was inhibited, possibly as a result of the competition between hydrogen and metal ions on the sorption sites, with an apparent preponderance of hydrogen ions, which restricts the approach of metal cations as in consequence of the repulsive force. As the pH increased, the ligand functional groups in adsorbent media (IRH) would be exposed, increasing the negative charge density on the adsorbent material surface, increasing the attraction of metallic ions with positive charge and allowing the sorption onto adsorbent material surface.

Effect of adsorbent media bed height: The results elucidated that when the adsorbent media bed height was increased, the percent removal of all heavy metal ions (each one alone) was increased too at constant other variables as shown in Fig. 3. The increased of bed height (h) meaning increased in the amount of adsorbent media, thus increasing the surface area of adsorbent material, hence increased the number of active sites in the adsorbent material surface i.e., increased the availability of binding sites for adsorption and consequently increase the heavy metal ions removal capacity on IRH.

This lead to increase the ability of adsorbent media to adsorb greater amount of heavy metal ions from SSAS at different initial concentrations and ultimately the percent removal of all heavy metal ions (each one alone) increased.

Effect of flow rate: The results illustrated that when the flow rate of SSAS of heavy metal ions was increased, the percent removal of heavy metal ions was decreased (each one alone) at constant other variables as shown in Fig. 4. This may be due to the fact that when the flow of SSAS of heavy metal ions increasing, the velocity of solution in the column packed with the

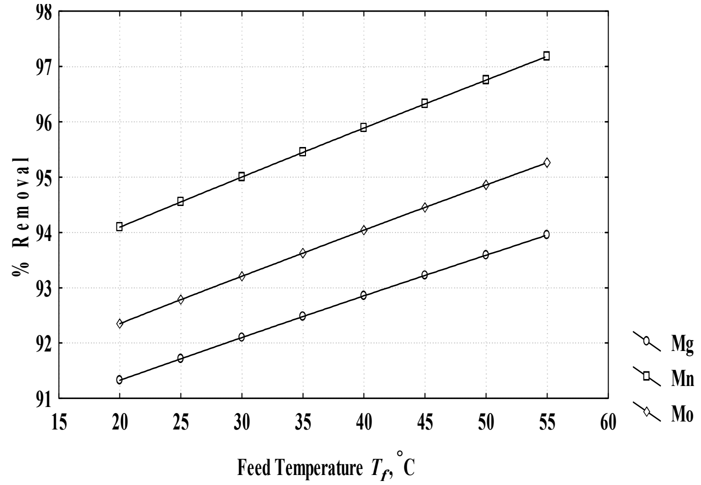

Fig. 5: Effect of feed temperature (Tf) on the percent removal of different heavy metal ions C_o = 5 mg/L, hb = 0.7 m, t = 60 min. and F = 5 mL/min

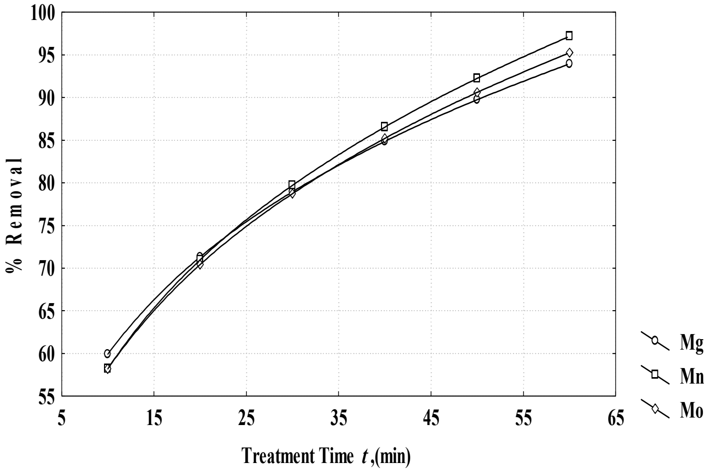

Fig. 6: Effect of treatment time (t) on the percent removal of different heavy metal ions C_o = 5 mg/L, Tf = 45°C, hb = 0.7 m and F = 5 mL/min

adsorbent media (IRH) was increasing too, so the solution spend shorter time than that spend in the column while at low flow rate, the SSAS of heavy metal ions resides in the column for a longer time and therefore undergoes more treatment with the adsorbent media, thus the adsorbent media uptake low amount of heavy metal ions from SSAS of heavy metal ions for high flow rate, therefore the percent removal of heavy metal ions was decreased when the flow rate was increased.

Effect of feed temperature: The results demonstrated that when the temperature of feed which was SSAS of heavy metal ions was increased, the percent removal of heavy metal ions was increased too (each one alone) at constant other variables as shown in Fig. 5. The effect of temperature is fairly common and increasing the mobility of the metal cation. Furthermore, increasing temperatures may produce a swelling effect within the internal structure of the adsorbent media enabling heavy metal ions to penetrate further. It was indicated that heavy metal ions adsorption capacity increase with increasing feed temperature from 20 to 55°C. This effect may be due to the fact that at higher temperature an increase in active sites occurs due to bond rupture.

Effect of treatment time: The results demonstrated that when the treatment time of SSAS of heavy metal ions increased the percent removal of heavy metal ions increased (each one alone) at constant other variables as shown in Fig. 6.

Table 4: Statistical equations of heavy metal ions removal using Iraqi rice husk

Heavy metal	Equation	(R^2)
Mg	$\%R = 2.0661 \times 10^{-6} \left(\frac{T_f \,.\, P \,.\, h_b \,.\, C_{P_{sol}} \,.\, t}{F \,.\, d \,.\, C_\circ \,.\, g} \right)^{0.251} (pH)^{0.322}$	0.975
Mn	$\%R = 4.0349 \times 10^{-7} \left(\frac{T_f \,.\, P \,.\, h_b \,.\, C_{P_{sol}} \,.\, t}{F \,.\, d \,.\, C_\circ \,.\, g} \right)^{0.286} (pH)^{0.295}$	0.981
Mo	$\%R = 6.6165 \times 10^{-7} \left(\frac{T_f \,.\, P \,.\, h_b \,.\, C_{P_{sol}} \,.\, t}{F \,.\, d \,.\, C_\circ \,.\, g} \right)^{0.275} (pH)^{0.308}$	0.973

This may be due to the fact that when the time of treatment of SSAS of heavy metal ions increasing and the velocity of solution in the column packed with the adsorbent material was remaining constant, the solution spend longer time than that spend it when the time of treatment decreased, so the adsorbent material uptake more amount of heavy metal ions from SSAS, therefore the percent removal of heavy metal ions from SSAS of was increased.

Statistical model: A statistical model was carried out on the experimental results obtained from this study. Regression Analysis and $\boldsymbol{\pi}$ Theorem was adopted to maintain a relation between the percent removal of different heavy metal ions and the feed temperature, flow rate, pressure, pH of feed solution, initial concentration of heavy metal ion, adsorbent media bed height, treatment time and column diameter.

These relations are shown in Table 4, which has a correlation coefficient (R^2) as explained.

where,
%R = Percent removal of heavy metal lon from SSAS
T_f = Feed temperature, (K)
P = Pressure, (Pa)
h_b = Adsorbent material bed height, (m)
$C_{P_{sol}}$ = Heat capacity of SSAS, (j/g, K)
F = SSAS flow rate, (m^3/s)
d = Interial diameter of sorption column, (m)
$C_\circ$ = Intial concentration of heavy metal lon, (g/m^3)
t = Treament time, (s)
g = Acceleration of gravity, (m/s^2)

UTILIZATION OF IRAQI RICE HUSK AFTER USES

Huge amount of IRH was lingered after using it in removal of heavy metal ions from SSAS. Utilization from IRH uses can be achieved in different ways shown below:

Employment of used Iraqi rice husk as a raw material to prepare promoted zeolite type Y catalyst: IRH waste which were adsorbed (Mg, Mn and Mo) ions from aqueous solutions at different operating conditions were segregated and classified according to its contain of above heavy metal ions (each one alone) and utilization from these remaining samples as a raw material in synthesis of promoted catalyst used in n-heptane isomerization which is zeolite type Y. The samples give different ratios of heavy metal ions to IRH. The ratios were between (0.05 to 5.5 wt%) for (Mg, Mn and Mo) ions (each one alone). IRH lingered with different ratios were firstly treated with 10% phosphoric acid (H_3PO_4) for 24 h for preliminary removing all impurities. Then they were well washed with double distilled water, filtered, dried in air and calcined at 750°C for 6 h. 12 g of calcined IRH were then subjected for dissolution in sodium hydroxide NaOH (4 M) followed by refluxing at 90°C for 12 h. After that concentrated hydrochloric acid (HCl (37%)) was added to the aforementioned base dissolved IRH for complete precipitation. IRHs were filtered, washed with excess distilled water to be freeing from chloride ions and finally dried in an oven at 120°C for 6 h. Zeolite type Y was synthesized using prepared IRH above as a silica source in the following method. A 500 mL Teflon beaker containing a magnetic stirrer was washed with deionized water. Sodium hydroxide of 1.6616 g was added slowly to deionized water and stir until clear and homogenous solution appeared for about 5 min. The aqueous solution of sodium hydroxide was ready for the preparation of seed gel. The gel was prepared according to the following molar chemical composition: 10.67 Na_2O: Al_2O_3: 10 SiO_2: 180 H_2O. Two millilitres aqueous solution of sodium hydroxide was added to 0.7515 g sodium aluminate oxide until a homogenous mixture was formed; 1.5361 g of prepared IRH above was added separately to 5.5 ml sodium hydroxide aqueous until homogenously mixed. Both of the preparations were heated under vigorous stirring to obtain a homogenous mixture. The sample was aged for 24 h at room temperature in the Teflon bottle. The aluminate and silicate solutions were mixed together in the polypropylene beaker, subsequently stirred for 2 h with the purpose of making it completely homogenized. This combined solution was used as the feed stock gel (Rahman *et al*., 2009: Mohammed *et al*., 2008). The flow chart of the process is shown in Fig. 7. The synthesized zeolite type Y which was in sodium (Na^+) powder form, mixed with 15% montmorillonite clay as a binder then mixed with water to form a paste. A spherical shape (0.5 cm) was formed, dried overnight at 110°C. In order to make a promoted catalyst ready for test in any process, hydrogen zeolite (H-zeolite) form must be prepared. The M-HY-zeolite (where M is one of heavy metal ions used) was prepared by exchanging Na^+ ions in the sodium form zeolite type Y with ammonium chloride solution NH4Cl. In order to obtain

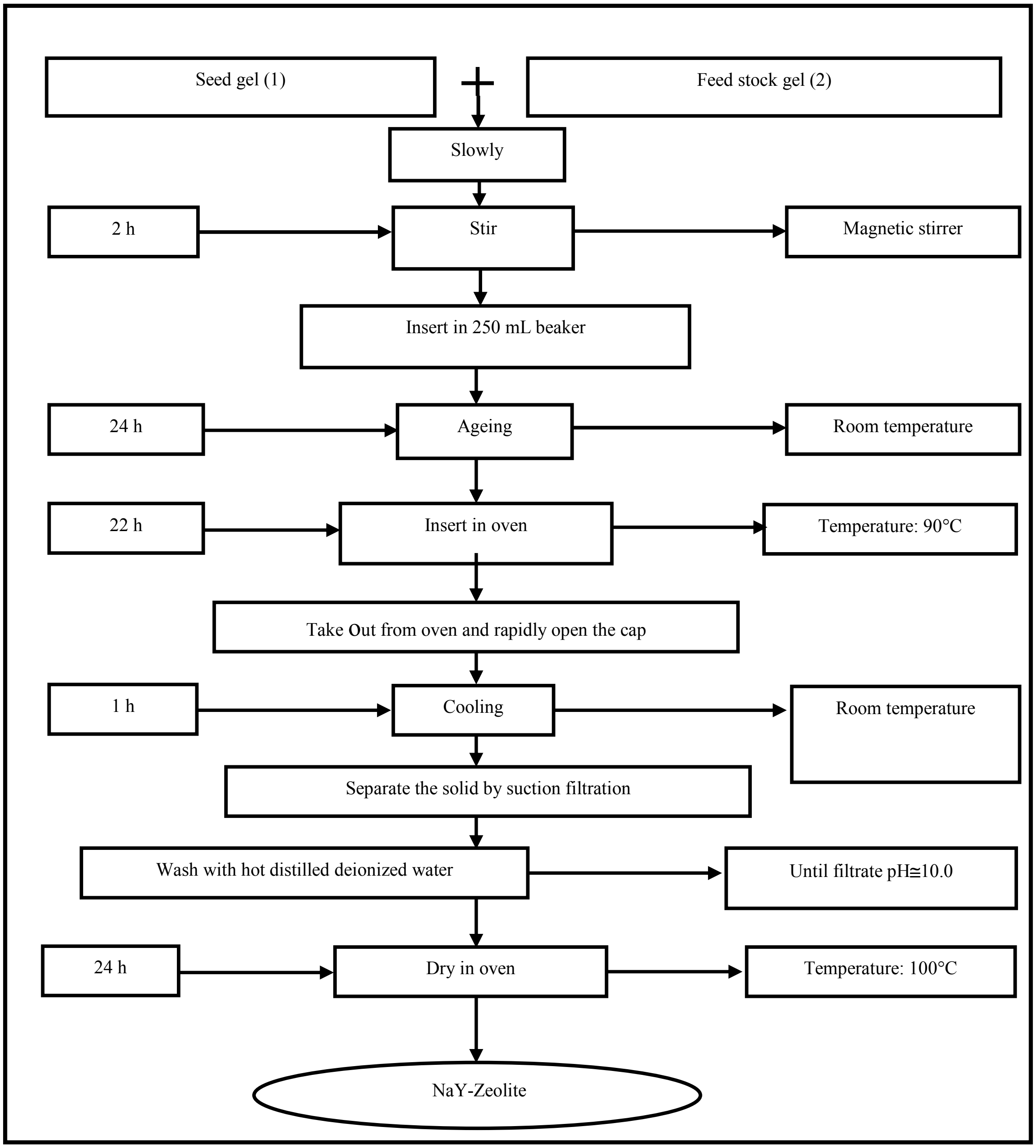

Fig. 7: Flow chart of the synthesis of type Y-Zeolite catalyst using Iraqi rice husk (Rahman *et al*., 2009)

ideal degree of ion exchange the technique of multi-steps (three times repeating) was used. Thus, the first step, 2N of ammonium chloride solution (26.75 g of NH4Cl in 250 mL of distilled water) contacted with 90 g of prepared M-NaY-zeolite with stirring for 2 h. In the second step, the procedure in the first step was repeated under the same conditions but on about 60 g of zeolite, which was taken from the total zeolite amount produced in the first step. Finally, in the third step, the procedure under the same conditions was repeated again but on about 30 g of zeolite, which was taken from the total zeolite amount produced in the second step. The exchanged ammonia zeolite were filtered off, washed with deionized water to be free of chloride ions dried overnight at 120°C and then calcined initially at 150°C for 2 h. The temperature was increased 75°C per

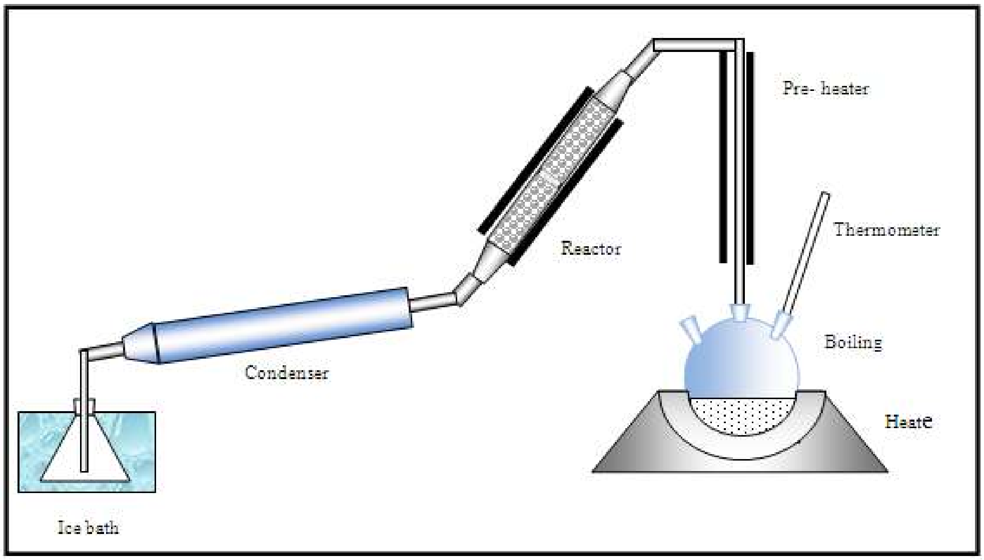

Fig. 8: Isomerization unit (Jawad, 2009)

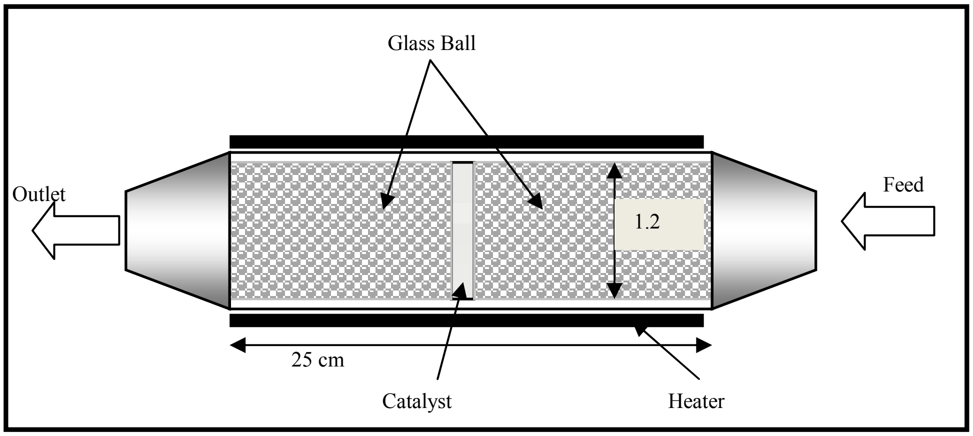

Fig. 9: Isomerization unit reactor (Jawad, 2009)

h until it reached 550°C and it was held constant for 5 h at this temperature. During calcination, ammonia and water were liberated and promoted zeolites which are (Mg+2HY-zeolite, Mn+2HY-zeolite and Mo+2HY-zeolite) were formed (Sherman *et al*., 1978).

Catalytic Activity of Synthesized Catalysts: The catalytic activity of synthesized promoted zeolite type Y catalysts was studied by applying n-heptane isomerization reaction. The n-heptane isomerization reaction was carried out in a laboratory isomerization unit shown in Fig. 8 and 9. This is achieved in a packed bed catalytic reactor of laboratory isomerization unit. The n-heptane supplied from Sigma Aldrich Co. and used as a raw material for isomerization process. The isomerization of n-heptane experiments were carried out in a laboratory isomerization unit at a temperature range of 300 to 400°C and atmospheric pressure for different quantities of prepared zeolite type Y catalysts. The n-heptane is evaporated at its normal boiling point which is 98.5°C and pre-heating the vapour before passing into the reactor which contains a known quantity of prepared zeolite type Y catalyst sample between two layers of glass wool and glass balls. The product vapour will be cooled in the condenser and condensed in the ice bath. After that samples of product collected to be tested by Gas Chromatography device (GC) (Dani, Model GC 1000 DPC). The isomerization results of n- heptane over six prepared zeolite type Y catalysts are given in Table 5. Results listed in Table 5

Table 5: N-heptane isomerization using prepared zeolite catalysts @ 350°C

Catalyst of heavy metal ions to Iraqi rice husk Ratio (0.5%)	Substances (wt%)								
	Propane	Butane	Isobutane	2,4-Dimethyl Pentane	2,3-Dimethyl Pentane	2-Methyl hexane	3-Methyl hexane	n-Heptane (isomerizes)	n-Heptane (unreacted)
HY-zeolite	3.11	1.65	2.03	–	–	–	0.66	7.45	92.55
Mg^{+2}HY-zeolite	–	2.35	3.74	4.55	15.25	1.56	2.39	29.84	70.16
Mn^{+2}HY-zeolite	–	2.76	3.81	5.03	16.84	2.33	2.84	33.61	66.39
Mo^{+3}HY-zeolite	1.53	–	5.09	17.57	20.43	8.13	–	51.22	48.78

Table 6: Hours lead to kill rat when it nurtured with treated Iraqi rice husk

Heavy metal ion adsorbed on Iraqi rice husk	Heavy metal ions (Mg^{+2}, $Mn^{+2}$and Mo^{+2}) to Iraqi rice husk ratio (wt%)								
	0.05	0.5	1	2	3	4	4.5	5	5.5
Magnesium, (Mg^{+2})	–	–	224	196	132	96	72	40	24
Manganese, (Mn^{+2})	–	224	200	180	153	132	88	72	36
Molybdenum, (Mo^{+3})	244	220	196	155	96	72	36	24	12

were calculated based on concentration of n-heptane in the output of the reactor measured by gas chromatography GC investigation with corresponding input of 99% n-heptane purity by the Eq. (1):

$$\text{Conversion (wt\%)} = \frac{(\text{Initial weight of n}-\text{heptane})-(\text{final weight of n}-\text{heptane})}{(\text{Initial weight of n}-\text{heptane})} \quad (1)$$

Employment of used Iraqi rice husk as a rodenticide: IRH waste which were adsorbed (Mg, Mn and Mo) ions from aqueous solutions at different operating conditions were segregated and classified according to its contain of above heavy metal ions (each one alone) and utilization from these remaining samples as a rodenticide without any treatment. The samples give different ratios of heavy metal ions to IRH. The ratios were between (0.05 to 5.5 wt %) for (Mg, Mn and Mo) ions (each one alone). Before the treated IRH wastes with the above heavy metals take to the rats, the rats were left for one week and nurtured with normal feed to make sure that rats were not suffer from anything leading to death. After that the rats nurtured with treated IRH wastes with (Mg, Mn and Mo) ions (each one alone), the results were fate the rats in a different periods as shown in Table 6. The inorganic pesticide, is one of the most important type of pesticide used in rodent control and perhaps the most important components used in this field are zinc, arsenic, lead, phosphorus, fluorine and aluminum inorganic compound. There are several ways to use these pesticides, which can be used by spraying the vegetative plants, in rodents places passing where the pesticide inter to the mouth of the rodent when its clean parts of their bodies, or through mixing with attractive materials to rodent like rice husk or bread or vegetables pieces. Characterized compounds of this rodenticide being used successfully to combat rodent and where they are used as toxin infectious for their secured effectiveness and severity of toxic, in addition to non-degradable and remain for a long time without changing their composition. There is more than one way to interpret the mechanical toxic effect of these elements compounds on rodents, which are:

- The compounds of these elements operate to prevent the phosphorylation process of Adenosine Diphosphate (ADP) material in the process of oxidative phosphorylation and thus preventing the formation of Adenosine triphosphate ATP material necessary in the storage of energy required for the rodent.
- These compounds linked with many important enzymes required from the rodent body and discourage work and these enzymes are dehydrogease, cytochrome oxidese, phosphatase where these inhibition process lead to an imbalance in the processes of chemical or biological eventually lead to the death of the rodent.
- The high concentrations of elements compounds lead to a deposition holistic and very fast for a protein in a living cell because it attack the sulphur bonds, which plays an important role in keeping the distinctive shape of the protein, it observed that the effect of these elements compounds are concentrated in the epithelium in the central gut of rodents.
- The low concentrations of these elements compounds leading to excessive drowsiness and lack of movement and the collapse of immune system and the failure of the ability to reproduce (infertility) of the rodent.

Employment of used Iraqi rice husk in electric generation as a low value material: In many agricultural countries producer of rice, such as Thailand, Malaysia, Sri Lanka and others (Jittima, 2011: Asanka and Shantha, 2011), the of residual rice husk are used in the generation of electrical energy, so it is possible to use rice husk to remove heavy metals from wastewater before using it in the production of electrical power and thus we have achieved two benefits from the use of rice husks and contributed to reducing the use of fossil fuels and thus preserve the environment in a more convenient and economical way by getting rid of two pollutants by one material.

CONCLUSION

The following conclusions can be drawn:

- IRH showed a good ability to remove heavy metals from SSAS using fixed bed adsorption unit. So, it could be recommended for removal of heavy metal ions from treatment plant wastewater in Iraq instead of other material like activated carbon because it is valid, cheaper, economical, easy and simplicity for using and has a high ability to adsorb heavy metal ions, can be used several times by costly regeneration method and can be used finally in another benefit uses.
- Maximum removal of heavy metal ions were (93.95, 97.18 and 95.26) % for heavy metal (Mg, Mn and Mo) respectively, at initial heavy metal ion concentration of 1 mg/L.
- The percentage removal of heavy metal ions was increased with decreeing flow rate of SSAS and initial concentration of heavy metal ions while the percentage removal was increasing with increasing of treatment time and the height of adsorbent material (IRH). For pH the percentage removal was decreased with increasing pH for (Mg, Mn and Mo) and Increased with increasing pH for other heavy metal ions.
- It can be prepared a promoted catalyst (which is zeolite type Y) for isomerization process from the residual samples of IRH that adsorb the heavy metal ions (Mg, Mn and Mo) from aqueous solution to produce a fuel of higher octane number and remove the hazards waste causes carcinogenic in economic and eco-friendly method.
- It can be prepared a rodenticide for rodent control from the residual samples of IRH that adsorb the heavy metal ions (Mg, Mn and Mo) from aqueous solution.
- It can use the IRH for generated electric power after using it to remove the heavy metal ions from wastewater, thus we getting rid of two pollutants by one material in an economical and eco-friendly method.

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