Think Tank List

Day 1-Afternoon Session

Abstract (#19286)

Title: Zeolite/Graphene Composite Support Used for Hydrodesulfurization Reactions

Authors: Islam Ali, T. A. Saleh

KFUPM

A composite of zeolite-graphene as a support decorated with molybdenum-cobalt and molybdenum-nickel was synthesized and evaluated as hydrodesulfurization (HDS) catalysts. Zeolite-molybdenum-cobalt or nickel (ZMoCo and ZMoNi) catalysts were also prepared for comparison in this work. The catalysts were evaluated in the hydrodesulfurization reaction of dibenzothiophene at a temperature of 300 ?C and hydrogen pressure 55 bar. The catalysts were characterized by a scanning electron microscope (SEM), an N2 adsorption-desorption isotherm, energy dispersive x-ray spectroscopy (EDS), Fourier transform infrared (FTIR), x-ray diffraction (XRD) and thermogravimetric analysis (TGA). The catalytic activity of prepared MoCo (Ni) catalyst supported on graphene doped zeolite (ZGMoCo or ZGMoNi) was investigated and compared with the same catalyst without graphene. The ZGMoCo was found to have the ability to reduce the sulfur content by around 98.3% after a 5 h reaction time and it showed higher catalytic activity compared to the ZMoCo or ZMoNi. This activity can be attributed to the improved surface area and better distribution of the active phases (molybdenum and cobalt or nickel) on the zeolite-graphene surface. SEM images showed the enhanced dispersion of the active phases on the support surface. BET measurements illustrated the improvement in the surface area due to the introduction of graphene to be 323.6 m2/g ZGMoCo compared to 257.3 m2/g ZMoCo. In addition, it was 312.5 m2/g (ZGMoNi) and 245.7 m2/g (ZMoNi). The present work is offering a convenient approach to prepare an effective HDS catalyst.

Abstract (19397)

Title: Mass-Producible Wrinkle Film for Selective Electrocatalytic Reduction of Carbon Dioxide

Authors: Hee-Tae Jung, Kyeong Min Cho, Woo-Bin Jung, Issam Gereige

KIAST

Electrocatalytic reduction of CO2 using renewable energy is a promising solution for sustainable synthesis of chemicals and energy storage. It has been well known that selective reduction of CO2 was strongly influenced by nanostructures, surface, composition (AuCu), surface chemistry (oxidation sate and

functionalization of organic molecules) and local pH. Despite much effort in catalytic performance, previous approaches have difficulties with the scale-up process because nanostructure control over large scale is not simple and cost-effective process. In this work, we accomplished highly selective CO2 reduction into CO via simple and scalable wrinkle catalyst film (~90 % of CO faradaic efficiency at -0.4 V vs a reversible hydrogen electrode (RHE)). Using various electrochemical analysis and finite element analysis (FEA) simulation, we confirmed that such enhancement is mainly due to high local pH in confined space of wrinkle film. Unlike previous approaches, our catalyst is several significant findings in CO2 conversion researches. This work provides significant enhancement of selective CO2 reduction by just local pH without considerable modification of nanostructure and other parameters (surface morphology, composition and surface chemistry), and demonstrated experimentally and theoretically. Importantly, the wrinkle shaped catalyst film is mass-producible, which could be fabricated over large scale with simple process of thermal shrinkage of metal-deposited polymer. This study is expected to open the door for a large family of catalyst platform for use in a wide range of catalyst applications not only electroreduction of CO2.

Abstract (19283)

Title: Ligand- Free Gold Nanoclusters Confined in Mesoporous Silica Nanoparticles for Styrene Epoxidation

Authors: Buthainah Alshankiti, Prof. Niveen Khashab

KAUST

We present a novel approach to produce gold nanoclusters (Au NCs) in the pores of mesoporous silica nanoparticles (MSN) by sequential and controlled addition of metal ions and reducing agents. The impregnation technique was followed to confine Au NCs inside the pores of MSN without adding external ligands or stabilizing agents. TEM images show uniform distribution of monodisperse NCs over the entire MSN. Since the NCs are grown in situ in MSN pores, additional support and high temperature calcination are not required to use them as catalysts. The use of MSN /Au NCs as a catalyst for the epoxidation of styrene resulted in very high conversion of styrene and high selectivity towards styrene epoxide. The catalysis reaction was environmentally friendly due to solvent free approach and low reaction temperature (60-80oC). Our synthetic approach can be extended to other metal NCs offering a wide range of applications.

Abstract (19312)

Title: Selective Aerobic Oxidation of Hydrocarbons by N-Hydroxyphthalimide-Based Catalyst for Cetane Enhancement

Authors: Maryam Altaher, Christos Kalamaras, Mohammed Alqahtani

Saudi Aramco

Gasoline compression ignition (GCI) utilizes gasoline-like fuels in low temperature compression ignition (CI) engines. As a result, thermal efficiency is increased comparing to conventional spark ignition (SI) engine, while NOx and soot tailpipe emissions are reduced comparing to diesel engine. However, this combustion strategy requires gasoline fuel with moderate ignition delay for cold start and high load demand conditions. This work investigates a process to control the ignition characteristics of gasoline to widen the GCI engine operation conditions. Selective aerobic oxidation of hydrocarbons using N-hydroxyphthalimide (NHPI) based catalyst under moderate reaction conditions has been suggested as an effective method to produce high cetane components like peroxides.

Toluene was used as a representative molecule for this work, since aromatics were the only hydrocarbon family that found to produce peroxides under the studied conditions. The produced peroxide concentration was quantified by titration using triphenylphosphine (Ph3P) followed by Gas Chromatography (GC) analysis. A detailed parametric study was performed using autoclave batch reactor to optimize the reaction conditions as a function of peroxide yields. In addition, supported NHPI catalysts over several porous materials were synthesized and screened. Thermal Gravimetric Analysis (TGA) was used to quantify the amount of NHPI loaded on the supports. It's been found that bare NHPI enhanced the formation of peroxide twice than supported NHPI. The bare NHPI was proved to be a robust catalyst that enhanced the cetane number by 30%. Selective aerobic oxidation of toluene using NHPI-based catalysts is found to be a promising technology to control the ignition characteristics of fuel and hence enables GCI engine concept.

Abstract (19359)

Title: Synthesis of a Novel Polymeric Vermiculite Nanocomposite via Interfacial Polymerization and its Applications

Authors: Abdullah A. Basaleh, Muhammad H. AlMalack,Tawfik A. Saleh

KFUPM

Interfacial polymerization was employed for the synthesis of low-cost adsorbent from clay mineral. In this regard, vermiculite was modified with a polyamide chain to enhance its adsorptive capacities for decontamination of dyes from aqueous solution. The synthesized vermiculite Nano-composite was characterized using scanning electron microscope coupled with energy dispersive spectrometer (SEM/EDS), X-ray diffraction (XRD), Fourier transform infrared (FTIR), and Brunauer–Emmett–Teller (BET).The characterization indicated that the polymer chain was attached to the surface of vermiculite. Adsorptive capabilities of the produced adsorbent were tested for Methylene Blue (MB) removal from aqueous solution. The effect of various adsorption parameters including pH, dosage, initial concentration, and temperature was investigated. The obtained experimental kinetics was fitted to pseudo-first and pseudo-second-order kinetic models, where pseudo-second order was best followed. Moreover, experimental equilibrium data were fitted to various isotherms including Langmuir, Freundlich, Temkin, Dubinin – Radushkevich, and Sips, where Langmuir model was best followed. The produced adsorbent

showed high removal efficiency for MB (99 %) and adsorption capacity of 76.4 mg/g. The thermodynamic study showed that MB removal using the synthesized material is spontaneous, favorable and endothermic.

Abstract (19391)

Title: Accelerated Carbonation Curing of Portland Cement Blended with Natural Pozzolana

Authors: J.H. Seo, Issam Amr, S.M. Park, Rami A. Bamagain, Bandar A. Fadhel, H.K. Lee

KAIST

Anthropogenic CO2 emission from the production of Portland cement has been taking a heavy toll on current Earth's atmospheric environments [1]. Accelerated carbonation curing (ACC) of cementitious materials is a feasible means of practically fulfilling the carbon capture and storage (CCS) [2,3]. ACC of Portland cement-based materials not only gives rise to fast strength gain but also facilitates storing a large volume of CO2 through the precipitation of stable carbonates [2,3]. On the one hand, the partial replacement of Portland cement with natural pozzolana has been consistently drawing significant attention for manufacture of cementitious materials with reduced greenhouse impact [4]. This paper summarizes a recent work conducted by the authors [5] in order to investigate CO2 uptake capacity of accelerated carbonation-cured Portland cement blended with volcanic ash as a natural pozzolana. The effects of ACC and volcanic ash content are discussed under the theme of CCS [5].

Abstract (19521)

Title: Behavior of Oxygenated Organic in High Pressure of Pure Oxygen Environment

Authors: Walid M. Alalayah

KAU

Technologies for removal of volatile organic compounds (VOCs) is one of the greatest challenges to environmental engineers. The objective of this study was investigated the oxygenated organic in a medium of high pressure using molecular oxygen. Ethanol as an oxygenated organic and simple molecule was subjected to series of pressure and temperature utilized a pressure, volume and temperature (PVT) system as a reactor without any catalysts. The products of the chemical reaction was analyzed and determined to have a normal mass balance between ethanol removed and increasing the product with increasing the pressure, therefore, the results showed that the pressure has a significant impact on the oxidation pathway of VOCs and lead to the complete oxidation of ethanol to produce carbone dioxide and water. The experimental results analyzed by gas mass chromatography GC-mass indicated that different peak's product at different pressure.

Abstract (19402)

Title: The Separation of Water-Insoluble Benzene Isomers by Cucurbit[7]Uril Solution

Authors: Gengwu Zhang, Niveen M. Khashab

KAUST

Disubstituted benzene isomers such as xylene, dichlorobenzene, dibromobenzene, chlorotoluene and others are often used for many polymers, plastics, fibres, solvents and fuel. The separation of these isomers has been as one of the world-changing separations due to their identical molecular weights, similar structures, close melting and boiling points. For para isomers, their melting points are always around or above room temperature. So they can be separated by fractional crystallization or low temperature fractional crystallization. However, the separation of ortho and meta isomers was difficult. The traditional method is azeotropic distillation or extractive distillation. However, such methods work at high temperature, which mean high energy costs. Trying to find high efficiency and low energy consumption methods always attract much attention for chemists and materials scientists.

Herein a two-phase extraction method was reported for the separation of water-insoluble ortho-disubstituted benzene isomer from its mixtures by cucurbit[7]uril (CB7) solution in room temperature. 1H NMR spectra and GC-MS shown that the separation efficiency can be more than 90%. Moreover, the exchange rates of CB7 and xylene isomers were calculated through variable-temperature 1H NMR spectra and 2D EXSY spectra, which further indicated that the selective recognition between CB7 and xylene isomers were due to the size-matching effect.

Abstract (19356)

Title: Direct Aromatization of Light Hydrocarbons Using Metal-Doped Zeolite Catalysts

Authors: Yaming Jin, Mostafa Matar, Omer Koseoglu, Abdullah Aitani, Ziyauddin Qureshi, M. Naseem Akhtar, Saad AlQahtani, Hassan Al-Asiri

Saudi Aramco

Light paraffinic naphtha within C5-C6 range has been historically a low-value hydrocarbon stream originating from refinery and gas plants. Conventional reforming technology is not applicable for aromatization of light alkanes (C6 and lighter). Instead, a non-oxidative dehydroaromatization (DHA) process has been found to be an effective conversion route of light alkanes to aromatics. The complex reaction network of DHA process necessitates multifunctional zeolite based catalysts.

A new catalytic conversion technology that can upgrade a large quantity of surplus light naphtha in Aramco's refineries and NGL fractionation plants to value added products such as aromatics is being studied. Zeolite based multifunctional catalyst systems, e.g. the hydrogen form MFI zeolite doped with selected metal functions have been investigated for converting light naphtha feed to monocyclic aromatics such as benzene, toluene, and xylenes. The multifunctional metal-doped HMFI catalysts result in significantly higher aromatics yields than undoped HMFI catalysts.

In this paper, we will present our recent results on light naphtha aromatization using various metal-doped zeolite catalysts. Catalyst synthesis variables and their impact on aromatization reactivity will be discussed in correlation with mechanistic understanding.

Abstract (19219)

Title: Advanced Materials Characterizations for Identifying Corrosion-related Challenges in Water Supply System

Authors: Anaam H. AlShaikhAli, Yahya T. AlJanab

Saudi Aramco

The formation and accumulation of unknown solid deposits can adversely affect the sustainability of the oil and gas production operations, such as downhole producing wells, pipelines and valves etc. These solid deposits have the potential to form at any part of the aforementioned processes, which could cause serious issues for oil and gas industry that affect productivity and operational continuity and subsequently loss of revenue. For example, deposit formation in pipelines could lead to serious issues, such as, decline in flow rate, reduced system reliability, and the risk of full or partial blockage.

In this study, corrosion and metal loss problems at one water supply system were investigated. The objective of this study was to determine the nature and compositions of deposit formation and any corrosion-related components. This will help to establish the causes of deposit formation and consequently develop solutions to maintain the structural integrity of the water supply and injection pipelines.

The findings from this case study will be demonstrated based on the data obtained by applying various advanced analytical techniques such as environmental scanning electron microscope (ESEM), X-ray diffraction (XRD), fourier-transform infrared spectroscopy (FTIR) and thermogravimetric analyzer (TGA). Analysis of the deposit samples collected from several sites of the water supply network reveals that the deposits comprised of mixtures of inorganic and organic constituents. The inorganic constituents were found to be more predominant in all samples. These are comprised of various levels of Ca-rich and Fe-rich compounds, which are typical of scaling and corrosion products, respectively. It was found that Aragonite- and Calcite- $CaCO_3$ were identified as the primary constituents of the scale products in the samples whereas Mackinawite-$FeS_{0.9}$, Siderite-$FeCO_3$ and Magnetite-Fe_3O_4 were identified as the primary constituents of the corrosion products. The organic part was found to be a mixture of hydrocarbons,

amines and sulfur-containing compounds. Traces of the corrosion inhibitor used in the downhole squeeze treatment were also detected.

Abstract (19337)

Title: Novel Multi Functional Catalyst for CO2 to Light Olefins

Authors: Ahmad Alrefaei, Isidoro Morales, Wei Xu, Ayyaz Muhmmad & Abdulrahim Alzahrani

Saudi Aramco

The rapid growth in the olefins industry requires an additional feedstock to sustain its growth production. In the petrochemical industry, a high quantity of CO2 is generated as a byproduct from several important chemical processes. The current practice is to release CO2 into the atmosphere, an inefficient utilization of an existing carbon source.

Currently, there are two main routes to convert CO2 back to valuable light olefins, (1) Ficher-Tropch route, which converts CO2 into syngas first and then transfer syngas into olefins, and (2) methanol to olefin route, which hydrogenates CO2 into methanol first and then transfers methanol into olefins. Both routes are complicated and require different catalyst phases, under different reaction conditions.

In this study, an innovative multifunctional catalyst design and synthesis will be presented. The advantage of one step CO2 to olefins, using these catalysts, will be discussed.

Abstract (19488)

Title: The Role of Ammonium Fluoride(NH4F) in The Synthesis and Characterization of A 2D Zeolite

Authors: Alhassan Ibrahim, Saheed Adewale Ganiyu, and Khalid R. Alhooshani

KFUPM

To investigate the role of ammonium fluoride(NH4F) in the synthesis and characterization of a 2D zeolite ZSM-35 of ferrierite-like morphology, we first synthesized ZSM-35 in an alkaline medium and then subsequently in a varied amount of NH4F media from (0.01g to 0.03g). we observed that the degree of crystallinity increased, mesoporosity was enhanced as observed from our N2-adsorption-desorption isotherms characterization base on Brunauer–Emmett–Teller (BET) calculation of the surface area, the crystal size and shape were altered. This observed trend has a strong correlation with the increasing F/Si ratio from (0.01g to 0.03g) of NH4F in the form of H–[F]–ZSM-35 as well as decreasing crystal size which can hopefully lead to nano-particle size ZSM-35 which has even greater potential as a catalyst.

Again Bronsted acidity was found to have reduced as the amount of F/Si ratio increase from (0.01g to 0.03g) of NH4F compared the to ZSM-35 synthesized in Alkaline medium. Hence the use of ammonium fluoride(NH4F) media in the synthesis and characterization of ZSM-35 zeolite catalyst of the ferrierite morphology has proven that the properties such microporosity, mesoporosity as well as molecular sizes of these zeolite materials can be tailored to suit our desired heterogeneous catalysis application.

Abstract (19706)

Title: Construction of a Layered Polyelectrolyte-Coated Silica with Aspartic Acid for Cd(II) Removal

Authors: Zakariyah A. Jamiu, Shaikh A. Ali

KFUPM

Highly efficient porous adsorbent has been developed by simple and inexpensive surface modification of mesoporous SBA-15 via an alternate adsorption of cationic poly(diallyldimethylammonium ion) and anionic poly(diallylaspartate). The nature of the charge on the surface after modification was confirmed by Zeta potential measurement. The surface morphology, topography and its textural properties were examined by atomic force microscopy (AFM) and Nitrogen adsorption/desorption respectively. TGA has been performed to ascertain the amount of polymer layer on the silica material. Multi-parameter isotherm models were used for the analyses of experimental data. The new protocol is found to be very impressive in the removal of toxic Cd(II) pollutant with an experimental maximum uptake capacity of 160 mg g-1.

Abstract (19220)

Title: New Advances in Pillar Fracturing Using Emulsified Resins

Authors: Nour O Baqader, Qasim A Sahu, Rajendra A Kalgaonkar and Khalid R Noaimi

Saudi Aramco

In hydraulic fracturing, a conventional proppant pack may lose up to 99% of its conductivity due to gel damage, fines migration, multiphase flow, and non-Darcy flow. Therefore, the concept of pillar fracturing was developed to generate highly conductive paths for hydrocarbon to flow. The success of the pillar fracturing treatment depends on delivering the proppant as pillar stages with a good suspension. This suspension keeps the proppant within the stage, prevents the proppant from diffusing out of the stage, and improves the mechanical strength of the pillar during closure. Resin based chemistries were proposed in the literature for proppant pack consolidation. However, most of these resins are incompatible with the aqueous fracturing fluids. This warrants for special precautions to be undertaken during pumping of the treatment to avoid formation damage.

We have improved the design of pillar fracturing by the improve of the strength of our developed new epoxy chemistry to substitute the porous proppant pack in the fracture with an isolated structure of propped pillars containing a network of open channels. We have used different types of epoxy cross linkers also different Nano-filler materials. This curing agents and fillers provided epoxy with excellent properties on mechanical strength. This is important to prevent epoxy proppants pillars form diffusing out and enhancing it stability and resistivity under downhole closure stress.

This paper further discusses the experimental procedures to test compatibility of the newly developed chemistry with crosslinked fracturing fluids, optimization to use the minimum concentrations, and making hard plugs of proppants pillars mixed with Nano-fillers under pressure and temperature (up to 350°F). The mechanical strength of the created pillars was evaluated using bench top open loading frame to confirm that the created pillar will resist the closure stress and keep the fracture open.

Experimental results showed that the embedded fluid after gelation can transport the proppant during the injection and closure time without settling, thus avoiding any issues with proppant screen outs. The compatibility test showed that different concentrations of the embedded gel fluid (from 20-50 vol %) was compatible with crosslinked water based-fracturing fluid and fracturing fluid additives. Moreover, this new chemistry was able to suspend the proppants. Additionally, the enhanced strength of the consolidated proppant pack showed acceptable mechanical strength enhancement with the developed fluid system where the proppant pillar can greatly hold the fracture open at high closure stress.

Abstract (19490)

Title: Selective PalladiumCatalyzed Synthesis of Diesters

Authors: Muhammad Sharif

KFUPM

The development of sustainable processes for chemical synthesis, energy and petrochemical technologies is one of the major challenges and noteworthy task for 21sr century. Notably, catalysis is a key technology for achieving more sustainable processes in the chemical, pharmaceutical and material industries. Currently, more than 80% of all chemical products are made via catalysis. In this regard, the development of more selective, cost-effective and durable catalysts constitutes a key factor for the production of all kinds of chemicals today and in the future.

Novel unsaturated C10 diesters are produced via alkoxycarbonylation of ?-lactone 1 (3-ethylidene-6-vinyltetrahydro-2H-pyran-2-one), derived from the telomerization of CO2 and butadiene. Key for the selective valorization of 1 is the use of a catalytic system based on PdCl2, a chelating phosphine bearing electron-withdrawing groups and an acidic promoter. The unsaturated C10 methyl diester can be easily hydrogenated on Pd/C under mild conditions to afford its corresponding saturated diester. Subsequent hydrogenation using the homogeneous [Ru(acac)3]/Triphos catalysts gives 2-ethyloctane-1,8-diol in high

yield. The overall procedure allows synthesizing new building blocks for the manufacturing of renewable polymers and polymers processing materials.

Abstract (19242)

Title: Synthesis and Characterization Of CopperBased Hydrogels for Carbon Dioxide Separation Applications

Authors: Mona Al-Dossary

Saudi Aramco

Separation of CO2 from post-combustion flue gases is important for environmental and economic sustainability. In this presentation, a new method is reported to synthesize copper-containing polymer hydrogels for CO2 separation application. The hydrogel was made from nontoxic poly(methyl vinyl ether-alt-maleic anhydride) (PVM-MA) in the absence or presence of added carboxylate ligands: dicarboxylates, such as adipate and terephthalate or tricarboxylates, such as nitrilotriacetate (NTA) and trisodium citrate. The copper hydrogels are wet precursors to a new family of amorphous porous materials, consisting of a metal–polycarboxylate backbone and carboxylate spacer ligands between polymer strands engineered via non-covalent interactions. The optimal ratio of polymer to dicarboxylate to Cu2+ was 10 : 4 : 2.5.

Rheological measurements showed that the mechanical stability of the hydrogels was enhanced by the addition of supplementary dicarboxylate ligands. Scanning electron microscope (SEM) and cryo-SEM imaging revealed the formation of pores. This is further conformed by physical adsorption measurements. The Brunauer–Emmett–Teller (BET) surface area of the dried hydrogels was tunable due to the addition of supplementary dicarboxylate ligands. The BET surface area was increased from 177.96 m2/g in a dried hydrogel without added dicarboxylate to 646.9 and 536.4 m2/g by the addition of adipate and terephthalate, respectively. Moreover, addition of dicarboxylate ligands increased the pore volume and CO2 gas adsorption capacity. The copper-based hydrogel with dicarboxylate spacer ligands offers the possibility of a new material f

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Abstract (19599)

Title: Investigation of The Compatibility and Utilization of Heavy Fuel Fly Ash in Asphalt Concrete Applications

Authors: Ghouse Baig Mirza, Al-Mallack H.M

KFUPM

This research is focused on the exploring the possibility of utilizing heavy fuel fly ash (HFFA) generated as a waste byproduct from diesel and cracked fuel used for power generation in asphalt concrete pavements. The chemistry and compatibility of HFFA with local fresh asphalt is studied based on which a detailed investigation on its utilization in local asphalt concrete mixtures is carried out. Three different percentages of HFFA were mixed with fresh asphalt and the basic properties of modified binders including performance grade (PG) is evaluated. Chemical characteristics of HFFA and the leaching ability of its constituent elements are observed. Furthermore, the effect of two different percentage of HFFA as a mineral filler replacement in the aggregate gradation is investigated. The results showed that HFFA can be mixed easily and remains well compatible with asphalt. The TCLP test carried out indicated that use of HFFA in asphalt concrete may not pose any environmental concern. Lower concentration of barium is leached out in asphalt mixes with higher percentages of HFFA, which indicates that HFFA may help as adsorbent to control barium from leaching. Asphalt concrete mixtures with HFFA have shown improvement in Stiffness, temperature susceptibility and fatigue life. However, a significant effect of damage due to water is observed leading to use of anti-stripping agents. The overall results of the study provides and effective insight to the local industry utilization of waste product HFFA.

Abstract (19584)

Title: New Technology to Selectively Enter and Log Slim Openhole Multi-Laterals in a Gas Environment – Case

Authors: Abubaker Saeed, Saad Hamid

Saudi Aramco

The job results from an operation using a wireline-operated lateral access tool (LAT) with a production logging tool (PLT) on E-coil are presented. The objective was to successfully identify, enter and acquire production data in each of the openhole laterals as well as the main borehole in order to quantify production and identify any cross-flow.

This operation is enabled by the use of a wireline-operated LAT. The tool can identify where the lateral window is located in the well and provide orientation data. With the LAT, the bottom sub can be indexed to enable entry into the lateral, while sensors package would provide positive confirmation and identification of a particular, targeted lateral. The system is compatible with a number of mono-cable logging tools and can be deployed using both E-line as well as Coiled Tubing. This paper describes the operation in detail and discusses the output and evaluates the results, which demonstrate the efficiency and accuracy of finding and entering the laterals.

The operation was conducted on a well in Saudi Arabia which was drilled using underbalanced coiled tubing drilling (UBCTD) technique in 2013 and included three, slim openhole laterals. In early 2014, the well was put on production with unknown contribution from each of the lateral sections, but interlateral cross-flow was suspected, leading to the need for intervention. A number of approaches were considered with special consideration given to a new technology that had been developed locally and run with success on some other oil and water wells in the region. This technology had not been utilized previously in slim

openhole wells with predominantly gas production. Challenges were anticipated regarding how some of the sensors would perform over two critical areas: identification of the lateral windows and confirmation that the lateral had in fact been entered successfully. The results of this operation demonstrate that the sensors can operate successfully in this environment. The operator was able to acquire critical reservoir information about each of the openhole laterals as well as the main bore, enabling further understanding of well production and reservoir depletion efficiency.

This case study demonstrates the innovative application of LAT to enable the production logging (PLT) and evaluation of slim openhole laterals in a gas well drilled with UBCTD compared to previous cases which were predominantly oil producers and water injectors.

Abstract (19448)

Title: Modeling Catalyst Deactivation in Heterogeneous Fenton-Like Oxidation Reactions

Authors: Shaker Haji, Elamin Elkanzi, Turki Aljawder, Mohamed Sabea, and Shakeel Ahmed

University of Bahrain

One of the most crucial problems in catalysis is the loss of catalytic activity. When analyzing or designing a reactive system involving a decaying catalyst, a rate law adjusted for the catalyst deactivation should be utilized. An example of decaying catalyst is Fe3+-supported catalyst used in the heterogeneous Fenton-like oxidation reaction of organic compounds. In this work, the reaction rate of Fenton-like reactions (Fe3+/H2O2) is modelled – through separable kinetics – with a general rate expression that is written in terms of a rate law, describing the reaction kinetics on the fresh catalyst, and an activity term, accounting for the catalyst decay/deactivation. The model was developed for the catalytic wet peroxide oxidation of Reactive Yellow P2RN/181 dye at different initial concentrations using Fe-Y zeolite, which experienced notable deactivation. The catalyst activity was recovered by washing the catalyst, which indicated that the deactivation was due to fouling rather than iron leaching, structure collapse, or irreversible poisoning. It was found that the reaction rate followed Langmuir-Hinshelwood kinetics while the catalyst decay rate was first order in the present activity and first order in the concentration of fouling compound(s), which resulted from the dye degradation. The developed rate expression was further tested on two different dyes, namely Reactive Red RGB and Methyl Orange, undergoing decolorization on the same catalyst. The developed rate expression was also tested on Naproxen degradation over carbon nanotubes catalysts carried out at different temperatures (J. García et al., Catalysts 2019, 9, 287). The rate expression proved to satisfactorily describe the concentration-time trajectories in the two latter cases despite the differences in the catalysts' support and/or reacting organic species, which verified the robustness of the model. The model included parameters such as the reaction and decaying rate constants, reaction and decaying activation energies, adsorption constant, and enthalpy of adsorption, which were estimated through linear and non-linear regressions.

Abstract (19459)

Title: Analysis of Sustainable CCU Paths Producing Fuel Additive for CO2 Reduction with Computer-Aided Tool

Authors: Hyungmuk Lim, Wonseok Chung, Hasan Imran, Ali S. Al HunaidyAuthors: Shaker Haji, Elamin Elkanzi, Turki Aljawder, Mohamed Sabea, and Shakeel Ahmed

KAIST

The global warming due to the anthropogenic greenhouse gas (GHG) emission such as fossil fuel usage and industrial processes has become an intensely debated issue recently. To manage the GHG (especially, CO2) emission in the industrial sectors, CO2 capture, utilization (CCU) technologies are being viewed as viable alternatives. In this study, various combinations of CCU technologies are applied to several CO2 sources, especially for producing fuel additives. Fuel additives increase the octane rating of fuels, act as corrosion inhibitors or lubricants so producing those from CCU technology can lead to environmental and profitable merit. Those CCU paths are analyzed concerning CO2 life cycle assessment (LCA) by different demands of fuel to get the optimal result with computer-aided tool called ArKaTAC3 (Aramco/KAIST-Tool for Analysis of CO2 capture & Conversion systems).

Abstract (19420)

Title: Dry Reforming of Methane with CO2 Over a Nimo-Mgo Nanocatalyst

Authors: Cafer T. Yavuz, Youngdong Song, Ercan Ozdemir, Sreerangappa Ramesh, Aldiar Adishev, Saravanan Subramanian, Aadesh Harale, Mohammed Albuali, Bandar Fadhel, Aqil Jamal, Dohyun Moon, Sun Hee Choi

KAIST

Large scale carbon fixation requires high volume chemicals production from CO2. Dry reforming of methane could provide an economically feasible route if coke and sintering resistant catalysts were developed. Here we report a molybdenum doped nickel nanocatalyst (NiMoCat) that is stabilized at the edges of a single crystalline MgO support and show quantitative production of synthesis gas from dry reforming of methane. The catalyst runs over 900 hours of continuous operation with no detectable coking. Synchrotron studies also show no sintering and reveal that 2.9 nm as synthesized particles move to combine into stable 17 nm grains at the edges of MgO crystals above the Tammann temperature. Our findings enable an industrially and economically viable path for carbon reclamation.

Abstract (19485)

Title: Development of a Novel Tetra-Metallic Electrocatalyst for The Commercial Viability of Electrolysers

Authors: Afzal Shah, Muhammad Asad, Mohammad Salim Akhter and Sadeq Al-Alawi

University of Bahrain

For realizing a zero carbon based energy economy, water splitting seems a sustainable and renewable source of energy. Water undergoes hydrogen evolution reaction (HER) and oxygen evolution reaction (OER) during electrolysis. However, amongst both the half-cell reactions OER demands more energy. Hence, the development of efficient catalysts for speeding up OER is a key for boosting up the commercial viability of electrolysers. To contribute in this domain we prepared a novel tetra-metallic catalyst (Co-Cu-Zn-Fe) by an electrochemical method using salts of cheaper metals. The preparation of this hybrid electrocatalyst involving synergistic enhancement in properties of the combining components is so for an unexplored matter. Fluorine doped tin oxide electrode was modified with the synthesized catalyst by a facile potentiodynamic method and the modified electrode was characterized by XRD, SEM and EDX. The performance of the catalyst examined by linear scan voltammetry in an alkaline medium of pH-13 demonstrated stunning OER catalytic role as evidenced by the achievement of 1 and 10 mA cm-2 current densities at the lowest ever reported overpotentials of just 47 and 216 mV respectively. To the best of our knowledge this is the first time of reporting a catalyst that surpasses even the performance of benchmark Pt catalyst.

Abstract (19588)

Title: Properties of supersaturated vanadium (V) electrolyte for high energy density vanadium

Authors: Faizur Rahman

KFUPM

According to Strategic Priorities for Energy Technology Program under Vision 2030, energy is a key driver for the country's development and economic growth. Efforts are being diverted to harness alternate forms of electrical energy, especially electricity from renewables (PV-Wind-CSP). It can be stated that massive electricity storage is the critical technology needed by the renewable power if it is to become a major source of base load dispatchable power.

Electricity storage systems are in high demand for large scale applications such as utility power supply purposes from renewables as well as conventional supply, load leveling in power plant, remote area power supply system and emergency back-up applications. The use of electricity generated from these intermittent, renewable sources requires efficient and cost-effective electricity storage systems (EES). For commercial and residential grid applications, major disruptions may occur with costs estimated to be tens of billions of dollars annually. Throughout the world, therefore, enormous effort and funding is currently being diverted for the development of suitable battery systems for these applications.

Amongst the new battery technologies currently under development around the world, the vanadium flow battery (VFB) appears to offer great promise as a low cost, high efficiency system for large-scale electricity storage. The vanadium flow battery is now moving towards commercialization in a wide range of stationary applications. It employs concentrated vanadium electrolyte which is the main component in the VFB as a charge storing medium. In this paper, the properties and stabilization studies of vanadium (V) electrolyte will be presented for high energy density vanadium battery at higher temperatures. The properties that will be discussed are: electrolyte density, viscosity, conductivity electrochemical behavior, solubility and electrolyte precipitation phenomena, and antiscalants to control precipitation of electrolyte at high temperatures. Recommendations will be made for optimum electrolyte composition that can be utilized in high temperature regions.

Abstract (19598)

Title: Sensitization of Nanostructured TiO2 Layer with Dye Extracted from Peels

Authors: Khalil Ebrahim Jasim, Najla Mirza AlQassas

University of Bahrain

Natural Dye sensitized solar cell (NDSSC) is one of the promising third generation solar cells. Due to simple, low cost and safe extraction method; natural dye extracts are very attractive as sensitizers of nanostructured TiO2 solar cell electrode. In this study, dyes from different materials peels were extracted. Light harvesting efficiency, absorbance, and fluorescence of the extracted dyes were measured. Preparation and assembly steps of NDSSCs using nanostructured TiO2 electrode using cynomorium coccineum, pomegranate, mangosteen skin and beets peels dye extracts will be discussed. Solar cell electrode topology using scanning electron microscopy (SEM) and X-ray diffraction (XRD) spectroscopy will be presented. It has been found that, the pomegranate peel solar cell is the most efficient cell with short circuit current density (Jsc) = 0.447 mA/cm2, open circuit voltage (Voc) = 0.449 V, fill factor (ff) = 41.4%, and cell power conversion efficiency (h) = 0.83%. While, the best performance (highest fill factor) was obtained using cynomorium coccineum solar cell, with Jsc = 0.099 mA/cm2, Voc = 0.363V, ff = 52.8%, and h = 0.19%. The investigation revealed that the extract of pomegranate peel, mangosteen skin and cynomorium coccineum have capability to be a promising sensitizer for dye sensitized solar cells. Finally, some challenges to enhance NDSSC will be discussed.

Abstract (19400)

Title: Clamp-on Flow Meters: a Review

Authors: Muhammad Arsalan

Saudi Aramco

Objectives/Scope: This paper addresses the need and challenges associated with the clamp-on flow and water-cut measurement techniques for efficient and reliable water management by production and reservoir engineering in multiphase flow environment. Furthermore it reviews the available clamp-on measurement techniques and evaluate their strengths and weaknesses.

Methods, Procedures, Process: Real time flow monitoring and control is essential to optimize oil and gas operations. Multiphase flow meters are an integral component of the overall process. The capability to measure watercut in individual pipes and flow lines can be a key enabler for efficient water management and production optimization. Several watercut measurement techniques are known to the industry that are used widely, however, may not be suitable for efficient and reliable on-demand watercut measurement from outside of the pipe or flowline. In this work the challenges involved in clamp-on watercut measurement are described such as multiphase flow; pipe sizes; restrictive form factor; power requirements; measurement and deployment complexity; scaling and corrosion; and erosion in presence of sand and sediments among the others.

Abstract (19371)

Title: Effect of Acid and Sour Conditions on Ceramic Proppant

Authors: Abdullah S. Al-Enezi, Nayef M. Alanazi, Abdullah M. Al Moajil and Anaam H. Shaikh

Saudi Aramco

Hydraulic fracturing is well known process at oil and gas wells to enhance the productivity of these wells. Throughout this process, ceramic proppant is widely used in to hold the fractured channel opened, to allow the gas or crude oil to flow out through the well. Nonetheless, these channels are sometimes blocked by scale and clays, therefore, acid stimulation process is required. In this study, the proppant was investigated using high pressure and high temperature autoclave testing to study the effect of sour field and acid conditions on the proppant structure. The proppant was analyzed by Environmental Scanning Electron Microscopy (ESEM), Thermogravimetric Analysis (TGA), Inductively Coupled Plasma - Mass Spectrometry (ICP-MS) and X-ray Powder Diffraction (XRD). The results show the structure of proppant was affected by acid condition more than sour field condition. The iron content measured in the solution of acid condition test was found to be extremely higher than that observed on the solution test with sour field condition.

Abstract (19418)

Title: Invert Emulsion Fluids for HTHP Conditions

Authors: Vikrant Wagle, Abdullah Al-Yami, Sara AlKhalaf, Khawlah Alanqari

Saudi Aramco

It is of prime importance for a drilling fluid to have good and optimal rheology in order to achieve good hole-cleaning and have good barite sag resistance. Organoclay based fluids formulated with organoclay sometimes fail to maintain sufficient rheology during drilling. This is due to the thermal degradation of organoclay with time and temperature. To compensate the degradation of organoclay, excess amount of organophilic clay or low gravity solids (LGS) is added to the drilling fluid to enhance rheology. However, addition of organoclay or low gravity solids increases the plastic viscosity, decreases the rate of penetration thereby ultimately increasing the cost of drilling. Thus, there was a need to develop a drilling fluid with optimal rheology sufficient to give good hole cleaning and barite sag resistance.

This paper describes the formulation of three differently weighted invert emulsion drilling fluds viz. 70pcf low density, 90pcf medium density and 120pcf high density organoclay-free invert emulsion drilling fluids. These fluids which were formulated with the synergistic rheology modifier combination comprising of RM1 and RM2. The 70pcf, 90pcf and 120pcf organoclay-free fluids were hot rolled at 250oF, 300oF and 350oF respectively. Rheology of the 90pcf invert emulsion fluid was measured across high temperatures and pressures to observe their effects on the rheological properties of the fluid. The paper also describes the static aging and contamination studies of 90pcf and 120pcf fluids at 300oF and 350oF respectively.

70pcf, 90pcf and 120pcf organoclay-free invert emulsion drilling fluids formulated with the novel rheology modifier combination of RM1 and RM2 showed optimal rheology and low HTHP fluid loss. Static aging studies of 90pcf and 120pcf fluids at 300oF and 350oF respectively showed that the fluids are sag-resistant with low top-oil separation. Contamination studies of 90pcf fluid showed that the contaminants have minimal effect on the rheology and filtration properties of the invert emulsion fluid. HTHP rheology of the 90pcf invert emulsion fluid shows consistent rheology across high temperatures and pressures. The paper thus demonstrates the superior performance of the rheology modifier combination to achieve good rheological and filtration properties.

The present paper describes the results of the formulation of organoclay-free invert emulsion fluids with a synergistic rheology modifier combination comprising two additives RM1 and RM2. Invert emulsion fluid formulated with either RM1 or RM2 does not have good and optimal rheology required for successful drilling. However, the synergistic effect of these two additives RM1 and RM2 results in fluids with low PV and enhanced YP and low end rheology thereby increasing their capacity for better hole-cleaning and barite-sag resistance.

Abstract (19457)

Title: Stability Analysis of Diesel and Crude Oil Emulsions

Authors: Arafat Husain, Dr Shahzaad Kamal, Dr Mamdouh AL Harthi

KFUPM

The purpose of this study is to investigate the stability of the water-in-oil (W/O) and oil-in-water (O/W) emulsion by varying various parameters like water/oil ratio, surfactant type and concentration, mixing time and speed for diesel water emulsion and then demulsifying crude oil/ water emulsion .

The emulsion was prepared by adding oil into the glass beaker and adding a certain amount of surfactant to it. The mixture of oil and surfactant was then introduced to a high-speed stirrer and a certain amount of water was added gradually to maintain the oil to water ratio. The mixture was stirred at a particular speed for a specific time to obtain the desired emulsion. The emulsion type was tested with the help of conductivity and the dispersion test. The stability of the emulsion was recorded as a time taken by the emulsion to separate the oil from water. Demulsification of crude oil was observed by the bottle test.

The results obtained showed that the stability of the emulsion depends on surfactant type and concentration. For diesel no emulsion formation took place without adding a surfactant. However, for crude oil, a stable emulsion was obtained without addition of any surfactant. For diesel, Triton-series surfactant generated a highly stable emulsion at all investigated water/oil ratio. A critical stirring speed was observed for the formation of emulsion for diesel . The selection of surfactant is also very important and depends on the hydrophilic-lipophilic balance of surfactant. An optimum surfactant concentration for a stable water in diesel emulsion was observed which can be extremely valuable when it comes to economic use of the surfactant. Characterization techniques like droplet size, rheological behavior, and Zeta potential were utilized in understanding the stable behavior of the emulsion .While demulsification of crude oil was done by understanding the characteristics of a stable diesel water emulsion and destabilizing the emulsion accordingly.

Most of the published data deals only with crude oil emulsion and data on model oil and diesel water emulsion which is being looked upon as an alternative fuel for the future is limited. This study helps in understanding the behavior of emulsions and factors affecting their stability and instability for the emulsions. This study reveals that method of emulsion preparation also affects its stability.

Abstract (19357)

Title: Microbial Influence Corrosion Investigation in Gas Gathering Facilities

Authors: Husam Khanfar, Ammar Alsaqer, Abdulkareem Alqahtani, Nasser Huwaiji

Saudi Aramco

Microbial influence corrosion (MIC) becoming a worldwide problem in oil and gas industry. The Microbes involve in corrosion have different activities and its mechanisms are varies of deteriorating the facilities. The microbial colonization has negative impact results in environment, and operation. Therefor the requirements to identify and well diagnose the microbes with robust and advanced technology are essential and in highly demands in order to reduce the cost of control, treatment, and overcome the corrosion`s problematic.

A recent field and laboratory study of a failed gas gathering facility in Saudi Aramco revealed that the prematurely failed sweet gas flowlines were colonized with different groups of corrosion-causing microorganisms. The failure was manifested in a through-wall pinholes surrounded by scattered pits on the internal surfaces of the multi-section pipes. Specialized examination confirmed the suitability of the operating environment for the growth of microbes. The overall findings revealed detection of considerable numbers of different microbial groups with potential of MIC in the metallic sections of the flowlines, detection of less numbers and less microbial groups with MIC potential in the water samples, include general bacteria (BA), sulfate reducing archaea (SRA), acid producing bacteria (APB) and sulfate reducing bacteria (SRB), methanogens (MET), iron-oxidizing bacteria (IOB). The water analysis revealed non-corrosive environment, detection of pinholes at 6 o'clock position and localized pitting corrosion resembling MIC, detection of Fe- and S- rich corrosion products on the failed metallic flowlines sections

These groups of microorganisms can separately or collectively fail a system with the generation of highly aggressive species such as acids and sulfide. Metallographic examination confirmed the presence of microbial by-products in the through wall pit. The various analysis confirmed that microbially influenced corrosion was the main localized corrosion mechanisms leading to premature failures.

The presentation will discuss the field and laboratory work and used analytical techniques to assess the risk of microbial colonization on the integrity of the system. It will discuss the findings and the practical recommendations to curtail microbial activities and prevent reoccurrence of failure. Work is underway to implement the use of microbial control strategy and to deploy the devised monitoring strategy.

Abstract (19261)

Title: A New Approach to Maximize Hole Cleaning Efficiency

Authors: Meshari Alshalan, Abeer Alolayan

Saudi aramco

New type of drilling fluid based on a cross-linked synthetic polymer. The developed polymer is a superior hole cleaning product that moves drill cuttings, metal, shaving and other debris out of the well bore. In addition, the new polymer is capable of transporting cuttings when drilling metallic junk or partial losses formation.

The gel is generated by adding the first component (cross-linker) to the drilling fluid and then spotting the second component (PVA) diluted with water at designed percentages. The gel is spotted in the wellbore and then washed out. The strong carrying cpacity of the gel is expected to remove all cuttings and debris from the wellbore. The other conventional hole cleaning pills contain big solids and/or are expensive. The other method to clean excessive junk from wellbore is mechanically by running many hole cleaning trips that consumes a lot of rig time.

This practice has saved time by reducing the clean out trips. Moreover, the POLYSWEEP can provide a potential solution to hole cleaning when milling metallic junk or drilling at partial circulation. POLYSWEEP

has underwent to once successful trial test in deviation well (with partial losses). The POLYSWEEP was effectively capable of carrying all the shaving derbies and cuttings out from the wellbore throughout drilling operation with no troubles. Also, POLYSWEEP has proved that compatible for use in drilling fluid. POLYSWEEP is cost effective because it's not consist of several chemicals and it reduce number of wiper trips. Besides that, it is environmentally friendly as the compositions of fluid is not toxic.

Each fluid can be mixed in a short time, and both of them are not toxic and chemically inert. The new composition has potential of producing modified fluid for different application, such as: LCM and fracturing fluid.

Abstract (19335)

Title: 37 GC Upgradation Project with Consideration of Process Designed & Simulation from Owner Perspective

Authors: Tariq Salman Albarjas, Ali Yaraneri

PETROKEMYA/SABIC

This paper is focused on challenges faced during project execution for latest technology of 37 Gas Chromatographs Up-gradation. Since plant commissioning in 2009, old 37 Gas Chromatographs had sampling system process designed issue which caused frequent failures, longer cycle times which can't optimize plant parameters and process control which effected plant production, any problems on individual GC connections will affect the communication system which not allowed DCS operator take any actions to control parameters. Gas Chromatograph Analyzer is very critical for plant production enhancement. Will share main project stages Plan Do Check Act (PDCA) and typical project life cycle related to Up-gradation with latest technology of 37 Gas Chromatographs along with Primary Sample Conditioning System, Secondary Sample Conditioning System, Replacement of Headers Line, Hydrogen Gas (Carrier Gas) Purifier System, Safety Interlock and Auto Changeover System for Hydrogen Purifier, Gas detection System, moreover, Will share the Main Factors behind PROJECT success, requirements from project executive, how theses challenge were addressed and came up with resolutions.

As First time in the history of SABIC and Petrokemya, GC simulator provided for the training of analyzer team for enhancing our expertise and understanding of GC operation applicable for routine maintenance and troubleshooting which ultimately implemented GCs with state of the art qualities toward satisfied results and project successfully completed in April, 2017. This u-gradation helped operation to optimize the plant production at maximum level and minimize load on laboratory and utilize full benefit of the real measurement of the process streams to take proactive measures in case of the upset conditions as well as reliability of the product quality monitoring of propylene, butadiene, benzene and ethylene.

Utility lines and process return headers have been re-designed to overcome about the back pressure and freezing problems which were the main performance killers and bad actors of the analyzer systems.

Sample transport lines which caused polymerization and double phase also been re-designed and successfully installed, tested & commissioned.

The mentioned GC systems and safety systems have been re-designed based on the international and SABIC standards and addressed & registered as role model to implement for other SABIC affiliates

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Abstract (19263)

Title: Quantitative Rietveld Phase Analysis of Sludge Deposits from Refineries and Gas Plant

Authors: Husin Sitepu and Rasha A. Al-Ghamd

Saudi Aramco

Sludge deposits — that accumulate inside oil industry equipment — can cause failures and temporarily shut down refineries and gas plants. Recently, Sitepu and Al-Ghamdi (2019); and Al-Ghamdi and Sitepu (2018) described a new method to separate the non-hydrocarbon part (i.e., crystalline inorganic materials) from the hydrocarbon part (i.e., dichloromethane soluble) of the sludge deposits. Also, the researchers quickly and accurately identified the phase identification of X-ray powder diffraction (XRD) data of small amounts of crystalline inorganic materials, and performed quantitative Rietveld Phase Analysis for each of the identified phases. The method is fast and can accurately identify very small quantities of inorganic materials present in the sludge deposits.

In this paper, the method developed by Sitepu and Al-Ghamdi (2019) was extended to perform Quantitative Rietveld Phase Analysis of crystalline inorganic materials from: (i) a regeneration overhead acid gas condenser, (ii) water drawn off a pump's suction strainer in a gas plant, and (iii) inside the vessel's equipment of the sulfur recovery unit (SRU). The results revealed that the major phases are: (i) iron sulfide corrosion product with the hydrocarbon type of mixture of diesel and lube oil for sludge deposits from a condenser, (ii) calcium carbonate with the hydrocarbon type of lubricant oil for sludge deposits from a suction strainer for pumps, and barium sulfate with no organic hydrocarbon or polymer for sludge samples from a water recycling pump.

Moreover, the major phases for the small amount of crystalline inorganic materials, from different locations inside the vessel's equipment of the SRU, revealed that iron oxide corrosion products are found in the steam drum, and iron sulfate corrosion products are built up in the condenser. The presence of dissolved oxygen in the boiler feedwater is indicated by a high weight percentage of iron oxide corrosion products in the form of magnetite (Fe3O4), which appeared in the deposits collected from the steam drum. It is essential to quickly and accurately know the phases and their weight percentages of the small crystalline inorganic materials (non-soluble part) of the sludge deposits, along with the type of hydrocarbon soluble part. This knowledge can guide the field engineers at the refinery and gas plants, to facilitate efficient cleaning of the equipment by drawing up the right pro¬cedures, and take preventive action to stop the generation of those particular sludge deposits.