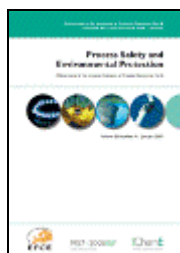


# **Process Safety and Environmental Protection**

**rok 2008, ročník 86**

**Číslo 1 (January 2008)**



**M. Streat, K. Hellgardt and N.L.R. Newton. *Hydrous ferric oxide as an adsorbent in water treatment : part 1. Preparation and physical characterization.* Pages 1-9.**

The preparation and physical characterization of granular ferric hydroxide as an adsorber of arsenic and other ionic species from aqueous solutions is discussed. The aim of the work is the preparation of granular ferric hydroxide in robust form using a temperature controlled freeze/thaw procedure. This procedure is described in detail and the physical properties of the derived material are compared with a commercially available product and a sample of granular ferric hydroxide prepared under ambient conditions. The importance of pH control, washing and dewatering are addressed and confirmed by SEM, XRD and nitrogen adsorption surface area measurements.

- **Keywords:** Arsenic; Granular ferric hydroxide; Freeze/thaw; Hydrous ferric oxide; SEM analysis; XRD analysis; Surface characterization; Hydrous ferric oxide; Preparation

**M. Streat, K. Hellgardt and N.L.R. Newton. *Hydrous ferric oxide as an adsorbent in water treatment : part 2. Adsorption studies.* Pages 11-20.**

The mechanism of arsenic adsorption onto hydrous granular ferric oxide is discussed in detail. The effect of arsenic speciation and complexation with the granular ferric hydroxide surface is discussed in relation to batch equilibration studies. Despite the complex nature of the binding mechanism, a Langmuir model provided a satisfactory fit of the data. Mini-column experiments have shown the effective sorption of arsenic from water in the pH range 7–8 and confirmed efficient elution using dilute mineral acid. Granular ferric hydroxide can be used for the removal of trace As(V) from water, eluted and recycled and moreover, the release of iron from the adsorbent was found to be negligible under appropriate operating conditions.

- **Keywords:** Arsenic; Granular ferric hydroxide; Adsorption isotherms; Adsorption mechanisms; Column studies; Elution; Regeneration

**M. Streat, K. Hellgardt and N.L.R. Newton. *Hydrous ferric oxide as an adsorbent in water treatment : part 3: Batch and mini-column adsorption of arsenic, phosphorus, fluorine and cadmium ions.* Pages 21-30.**

Freshly prepared granular ferric hydroxide using both a freeze/thaw and ambient temperature synthesis route are compared with a commercially available product for the adsorption of trace arsenic from water. The interference of competing ions, namely phosphate and fluoride has been studied in both batch and column mode. The effect of interfering anions is discussed in relation to the adsorption isotherms in the pH range 4–9. Also, breakthrough curves are examined to show the effect of anionic interference in packed column operation. The amphoteric nature of granular ferric hydroxide is illustrated by the adsorption of cadmium from water under controlled pH conditions.

- **Keywords:** Adsorption; Granular ferric hydroxide; Arsenic; Phosphate; Fluoride; Cadmium

**Bahtiyar Ozturk and Yilmaz Yildirim. *Investigation of sorption capacity of pumice for SO<sub>2</sub> capture.* Pages 31-36.**

The sorption capacity of pumice has been investigated for the removal of SO<sub>2</sub> from binary and tertiary mixtures with N<sub>2</sub> and N<sub>2</sub> + CO<sub>2</sub>, respectively. The influence of the presence of water on the adsorption of SO<sub>2</sub> has also been analyzed by moisturizing the adsorbent at different levels within the limits of applicability of Henry's law. SO<sub>2</sub> adsorption capacity of dry pumice was found as 16.26 mg SO<sub>2</sub> g<sup>-1</sup> pumice while for adsorption on moisturized pumice (22 wt% moisture) it was 33.4 mg SO<sub>2</sub> g<sup>-1</sup> pumice at 293 ± 2 K. When co-adsorption of CO<sub>2</sub> and SO<sub>2</sub> was carried out SO<sub>2</sub> adsorption on dry pumice was slightly reduced, but this counter effect of CO<sub>2</sub> was gradually removed by increasing water content of the adsorbent. Moreover, the acidic character of the adsorption products reduced the durability of pumice when it was moisturized.

- **Keywords:** SO<sub>2</sub> adsorption; CO<sub>2</sub> adsorption; Pumice; Flue gases

**Kai-Tai Lu, Kuo-Ming Luo, Tsao-Fa Yeh and Peng-Chu Lin. *The kinetic parameters and safe operating conditions of nitroglycerine manufacture in the CSTR of Biazzi process.* Pages 37-47.**

Nitroglycerine has been widely used as an ingredient of explosives and propellants for a long time. It is produced by the glycerine nitration reaction. Many fire and explosion incidents have occurred during its manufacturing process owing to its severe thermal instability in both the nitration reaction and the purification processes. The kinetic parameters of this reaction and the criteria for stable production have not so far been clearly identified. In this investigation, we estimate its reaction kinetic parameters from the experimental results obtained using a tubular flow reactor by a numerical analysis method. These reaction kinetic parameters are then used to evaluate the safe operating conditions in a CSTR for the Biazzi continuous nitroglycerine production. The results are important and useful in the production process of nitroglycerine.

- **Keywords:** Nitroglycerine; Kinetic parameters; Biazzi process; Safe operating conditions

**Diederik Nico Marcel Marie Weve, Jaime Sales and Rosa Nomen. *The S2S training and assessment tool for unexpected reactors : structure and knowledge base.* Pages 49-54.**

The S2S assessment tool for unexpected reactors aims to identify how reactive chemical hazards can exist in process units or plant equipment outside the reactors. The assessment tool can also be used as a training tool since it is based on simple concepts, combining the following items:

- A reaction triangle that describes the factors necessary for triggering a chemical reaction. The factors considered are temperature, concentration and residence time.
- Process streams with physical and chemical properties that can be mapped on the reaction triangle.
- Equipment or unit operations, which determine how process streams are positioned and moved in the reaction triangle. The design of the plant should ensure that these moves are safe. Equipment will have failure modes and can exhibit side effects that cause a shift in the reaction triangle that enables a reaction and may pose a hazard.
- The tool is presented as a computer program that generates discrete questions to identify potential hazards and explains the likely mechanisms. It is applicable to batch, semi-batch and continuous processes, and it assumes that the user has previously identified/characterized the reaction hazards through literature studies, calculations, experiments or other S2S assessment methods.

The tool can be found at the S2S web portal <http://www.s-2-s.org/>.

- **Keywords:** Unexpected reactors; Chemical hazard; Assessment tool; Reaction triangle

**Cen Nan, Faisal Khan and M. Tariq Iqbal. *Real-time fault diagnosis using knowledge-based expert system*. Pages 55-71.**

**Abstract**

Abnormal operating conditions (faults) cost process industry billions of dollars per year and can be prevented if they are predicted and controlled in advance. Advanced software applications, based on the expert system, has the potential to assist engineers in monitoring, detecting, and diagnosing abnormal conditions and thus providing safe guards against these unexpected process conditions. Abnormal operating conditions (faults) could be modeled and predicted with high confidence using software applications. A wide range of fault diagnosis methods exist which may be used to design safety systems. Due to the increased process complexity and possible instability in the operating conditions, the existing control systems have limited ability to provide practical assistance to both operators and engineers. This paper proposes a knowledge-based fault diagnosis method, which uses the valuable knowledge from the experts and operators, as well as real-time data from a variety of sensors. Fuzzy logic is also used to make inferences based on the acquired information (real-time data) and the knowledge. A computer-aided tool based on proposed methodology is developed on the platform of G2 expert shell using GDA (*G2 Diagnostic Assistant*) components. Performance of the methodology is verified using both industrial and simulated data.

- **Keywords:** Process monitoring; G2 system; Fuzzy logic; Fault diagnosis; Abnormal operation