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Explosion hazards of mixtures of reductants and oxidants used in reprocessing SNF

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Mixtures of reductant with nitrate oxidant are widely used or produced in technological operations radiochemical reprocessing SNF. The potential danger of these mixtures consists in the possibility of oxidation that can occur with a high rate and accompanied by the release of heat and gases, which may lead to the release of the contents of the apparatus or its deformation.

Some of the more dangerous operations are those in which it is possible to drying nitric acid solutions containing reducing agents, as at a certain temperature such dried mixture erupt like pyrotechnic compositions or gunpowder. In the practice of the radiochemical plants are known cases of accidents caused by intense exothermic processes. By the consequences they are fairly weak, however they led to the destruction of equipment, release of radioactive materials and even fatal.

The aggregate state of mixtures of reductants and nitrate oxidants can be divided into the following groups:

- nitrate solution (nitric acid and / or nitrates) with reducing agents;
- Mixtures of solid oxidizing and reducing agents (nitrates).

The maximum heat release and gas mixtures is achieved when ratio of reductant and oxidant is stoichiometric and hydrogen with carbon are oxidised to H₂O and CO₂.

During assessment of explosion risk of particular manufacturing operation at the presence of mixtures of reductants and oxidants need at least the following information:

- Temperature of the solution (mixture), at which in system begin interaction accompanied by the release of heat and gaseous products (Tonset);
- The rate of gas release (W_{gaz})
- Pressure that can be created in the device upon completion of the interaction process of the oxidant and the reductant.

We believe that by using of these values can be estimated the major aspects of explosion safety of technological operations - safe working conditions, the probability of failure and the possible consequences of the accident. To assess the real hazard and consequences of accidents need both information about the characteristics of the oxidative processes in these mixtures and the characteristics of apparatus in which the mixtures are using. First of all it is necessary to know the temperature at which the exothermic oxidation process starts, accompanied by gas evolution. If these processes are inevitable, for gas pipe capacity estimation of apparatus must be known maximum gassing rate. In case of sealing the gas lines, the pressures in the closed apparatus can be estimated from the total amount of the reducing agent, the quantities of the specific volume (V_{sp}) and the size of the free volume. In our works, we study the basic aspects of interaction between oxidants with reductants in both conditions the approximate for normal operation, and with regard to possible violations. The perspective processes of reprocessing SNF provide for the use for different purposes a number of new reductants - carbohydrazide, acetohydroxamic acid, glycine, hydroxylamine, metilaminkarbonat. Planned to introduce new operations - the destruction of ammonium nitrate with the participation of formaldehyde, denitration of uranyl nitrate with formic acid. The potential and real explosion hazards (the ability to exothermic reactions) for these reductants - nitrate oxidants mixtures is not known and requires mandatory study.

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