Risk assessment of the corrosion attack by metal dusting based on the gas composition

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Reliability and long-term stability are basic requirements when striving for a plants' best economical use and highest safety. In the field of syngas production a catastrophic form of corrosion, called "Metal Dusting", can occur and disintegrate the structural material. The starting time of the corrosion attack is hard to predict, but once it started, the attack proceeds fast. This destruction of components in short times can cause unplanned shut-downs and plant downtimes. The aggressivity of the attack depends on the conditions, in which the corrosion takes place, i.e. the temperature, total pressure, gas composition and flow rate. While alloying with high amounts of Cr, Al or Cu can help to form a protective oxide scale or inhibit the catalytic activity of Ni and Fe, an absolute prevention cannot be guaranteed. Hence, assessment of the risk for Metal Dusting needs to be as good as possible to enable highly reliable plants.

The Metal Dusting attack is driven by the deposition of carbon from the gas. The gases are typically mixtures of CO, CO_2, H_2, H_2O, and CH_4. Solid carbon can form by the reduction of CO or cracking of methane. Estimation of the attack then is often described by the potential carbon activity of individual carbon deposition reactions in the prevalent temperature and total pressure. However, other reactions such as the water-gas-shift reaction or the oxidation of the metals by the gas take place and change the gas composition. In our approach, we use FactSage to calculate the metastable thermodynamic equilibrium of the gas under suppression of graphite formation. The carbon activity in the metastable equilibrium then considers the interaction of all gas components. Comparison with experimental results show a better correlation than the carbon activity of the individual carbon deposition reactions. Ternary O-C-H diagrams with iso-activity lines of carbon allow direct evaluation of the impact of the gas components. Risk assessment can thus be improved.