PERP Program

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Chem Systems' Process Evaluation/Research Planning program has published a new report, ***Vinyl Chloride/Ethylene Dichloride (VCM/EDC) (99/00-3)***.

Commercial ethylene-based VCM technology utilizes direct chlorination of ethylene to produce ethylene dichloride, followed by pyrolysis to VCM and HCI. In the oxychlorination step, the hydrogen chloride released in pyrolysis is reacted with ethylene and oxygen to yield ethylene dichloride and water. The commercialization of oxychlorination technology paved the way for the "balanced process", combining direct chlorination, oxychlorination, and EDC pyrolysis reactions. This widely used commercial process produces only vinyl chloride and water.

A high proportion of VCM production capacity is based on this technology. However, a number of producers operate unbalanced schemes drawing HCl from other chlorination operations in an adjacent plant. A further variation runs in part on EDC brought in from other sources. Nevertheless, the balanced process is representative of the industry.

Direct chlorination can be operated either at low temperatures or at high temperatures. The low temperature (or subcooled) chlorination process has the advantage of substantially lower byproduct formation. The high temperature process requires alloy materials for all equipment in contact with the liquid, especially the reactor vessel where vigorous agitation causes erosion and corrosion. Iron is usually added to such reactors as anhydrous ferric chloride powder dissolved in EDC to act as catalyst.

However, the high temperature process has an advantage over the low temperature process in that the EDC product does not usually have to be washed to remove iron and subsequently dried azeotropically. Furthermore, because EDC's formation heat is six times its vaporization heat, the boiling reactor lends itself to a process whereby the vapor generated from the reaction exotherm may be used together with a fractionating column to purify the direct chlorination product itself, the dried oxychlorination EDC, and possibly the unconverted EDC stream recycled from the pyrolysis section.

The development of ethane-based technology for the production of vinyl chloride has been a long identified, albeit a difficult to realize, target of VCM process research. A number of companies have been involved in the attempted development of an ethane-based process, several processes have been patented, but as yet none have been commercialized. However, EVC has a 1,000 ton per year pilot plant at Wilhelmshaven, Germany and plans to build a commercial scale plant by 2003. The incentives for an ethane-based process are lower cost feedstock and a simpler process scheme. In concept ethane oxychlorination to VCM is a simple reaction:

$$2C_2H_6 + Cl_2 + 3/2O_2 \longrightarrow 2C_2H_3Cl + 3H_2O$$

However, the reactions that occur in practice are substantially more complex than suggested by the overall equation. Output from the oxychlorination reactor is a mixture of saturated and unsaturated products, the latter including vinyl chloride.

After separation of vinyl chloride product, the remaining mixture of saturated and unsaturated materials is hydrogenated in the hydrogenation reactor to convert the unsaturated materials to their saturated counterparts. The saturated materials from hydrogenation are recycled to the oxychlorination reactor.

Hydrogenation permits working higher-chlorinated unsaturates back to ethylene dichloride, which can then, by dehydrochlorination, give vinyl chloride product. Thus, the main loss to byproducts is from hexachloroethane made by oxychlorination of pentachlorethane. A simple diagram of the EVC reactor scheme is shown below.