Hydrogenation technology and catalysts reduce PVC byproducts

Approximately 34 million tons of polyvinyl chloride (PVC) are produced annually. A versatile material that is cost-effective to produce, it boasts numerous applications: building and construction, packaging, vehicle parts, electronics, medical devices, and more. However, it is also the production where an issue is found. Byproducts of PVC can be toxic, and removing and disposing of them can be costly.

These undesired chlorinated byproducts are formed during ethylene dichloride (EDC) cracking to vinyl chloride monomer (VCM) – the raw material for PVC production – and hydrochloric acid (HCl). Specifically, acetylene (C_2H_2) traces are formed and, when returned to the process in the HCl recycling stream, create said byproducts in the oxychlorination reactor. There is good news, however, in the fact that a more economically and environmentally friendly approach to PVC production is possible.

Hydrogenation technology

Hydrogenation technology presents itself as the solution to this problem. Approximately 860 tons of toxic chlorinated byproducts in a 300 kta production of VCM can be prevented when using this technology. Moreover, when selective hydrogenation of C_2H_2 to ethylene (C_2H_4) in HCl recycle streams is paired with fixed-bed catalysts throughout the VCM process, undesired byproducts can be avoided, and valuable raw material can be returned to the process.

Hydrogenation unit	Without (%)	With (%)	
1,2 Di-trans	0.010	0.002	
CCl4	0.101	0.067	
1,2 Di-cis	0.012	0.008	
1,1,2 Trien	0.035	0.002	
Total low boilers	**0.158**	**0.079**	**Δ = –0.079**
Tetrachlorethylene	0.112	0.001	
1,1,2,2 Tetrachlorethane	0.130	0.034	
Total high boilers	**0.242**	**0.035**	**Δ = –0.207**
Total byproducts			**Δ = –0.286**
1,2 EDC	**98.669**	**98.921**	**Δ = +0.252**

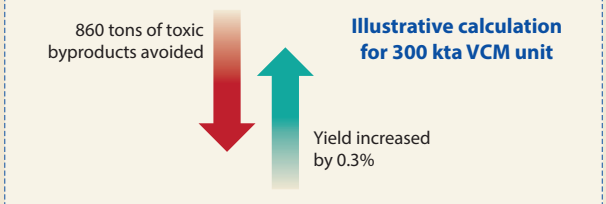

Figure 1 Calculation for 300 kta VCM unit

Evonik has been producing hydrogenation catalysts for acetylene-to-ethylene within the HCl recycle stream in VCM plants for the past 40 years. VCM hydrogenation catalysts are produced by Evonik based on proprietary knowledge. These catalysts are suitable for hydrogenation units as part of fluid-bed and fixed-bed VCM synthesis reactors. The hydrogenation catalysts have been successfully used with the highest performance in all existing VCM process technologies, such as Vinnolit, Oxyvinyls, INEOS, Mitsui, and Solvay.

Implementing the hydrogenation unit and avoiding acetylene reaching the oxychlorination reactor prevents chlorinated byproduct formation

Catalyst tailored to hydrogenation process

Developed by Evonik in co-operation with Vinnolit GmbH & Co. KG, the proprietary Noblyst E39 catalysts are a frontrunner in providing catalysts tailored to the hydrogenation process, and were tested and used in Vinnolit's commercial plants.

The series of palladium on silica crystal catalysts were designed specifically for the selective hydrogenation of acetylene-to-ethylene within the VCM production process, improving ethane dichloride selectivity and minimising byproduct formation in the oxychlorination step.

Implementing the hydrogenation unit and avoiding acetylene reaching the oxychlorination reactor prevents chlorinated byproduct formation. Acetylene will be chlorinated to low boiling compounds like di or tri chloroethane and high boilers like tetrachloroethane and tetrachloroethene. In addition, the polymerisation of acetylene and ethylene or acetylene and acetylene, including chlorination, can take place, causing chlorinated tar formation.

As seen in **Figure 1**, by reducing the said formation, the quality of EDC increased substantially; the EDC yield also increased by about 0.3%. So, we can conclude that the increased yield can potentially save producers using a hydrogenation reactor a significant amount in operational and capital expenditure costs.

Evonik Catalysts **Contact**: stefan.roeder@evonik.com

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