# 1. Design, Material Selection and Construction Strategies of Batch Chemical Reactors with a Fluoropolymer Coating for use in Fluorination Reactions

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**Abstract**

Chemical reactions involving hazardous and highly corrosive chemicals pose safety risks and present particular challenges in reactor design and the section of material of construction. This is particularly true for reactor systems involving the use of Hydrofluoric acid in fluorination reactions encountered in numerous synthetic pathways of active ingredients. Under such working conditions, because of increasing complexity of reactor requirements combined with high demands on versatility and performance, there is strong motivation to develop workable and cost effective design strategies which encompass a deeper understanding of the relationship between materials behavior and implications of material selection for design, operation, safety, reactor longevity and performance. Selection and compatibility of materials of construction, as well as manufacturing cost are key concerns for the existing reactor design used in fluorination reactions.

This paper details and discusses several strategies in reactor design where a fluoropolymer coating and lining are used to impart chemical resistance and passivation of the reactor's inner surfaces. Different lining options are compared in terms of suitability and efficacy and their performance are bench-marked in terms of (i) application ranges, (ii) mode of construction and lining/coating design and architecture, (iii) impact on reactor's shell design, (iv) handling mixing regimes, (v) managing Exo- and Endotherms as well as (vi) managing permeation through the Fluoropolymer coating/lining. In managing permeation, several design strategies will be discussed and compared with respect to their efficacy in handling reactions involving strong acids including Hydrofluoric acids and with strong oxidising agents.

The study also presents how accelerated aging testing of the Fluoropolymer coating/lining can be used as a qualifying criterion for optimal and practical reactor design. Practical and safety aspects related to installation, integration into plant design as well as maintenance will also be presented.

**Keywords**

Batch Reactor Design, Fluorination Chemistry, Fluoropolymer Coatings, Permeation, Accelerated Aging Testing, PTFE, PFA, Hydrogen Fluoride.