INVESTIGATION OF GAS-LIQUID DISTRIBUTION IN THREE-PHASE MONOLITH REACTORS

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by

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CERTIFICATE

This is to certify that the thesis entitled **'Investigation of Gas-Liquid Distribution in Three-phase monolith reactors'** submitted by **Ms. Deepali Chugh** to the Indian Institute of Technology Delhi for the award of degree of **Doctor of Philosophy** is a bona fide record of research work carried out by her under my supervision. The contents of this thesis have not been submitted to any other institutes or university for the award of any degree or diploma.

Date:

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-Deepali Chugh

ABSTRACT

The present study deals with the gas-liquid distribution offered by various liquid distributors operating under different operating conditions in co-current downflow monolith reactors. Gas-liquid distribution, both at a reactor level and at a channel scale, is a very crucial element and one of the key parameters in determining the performance of monolith reactors in three phase applications. It has been argued that a poor distribution can severely mask the inherent efficiency of a three-phase monolith reactor, no matter how much catalytic activity the monolith is designed for. Further, even if one has a good global gas-liquid distribution (reactor scale), there are no guarantees whether such a "good" distribution would also translate to an effective local irrigation within the channels. Both these aspects are addressed in this work.

Different laboratory scale distributors have been evaluated in monolith reactor using gravimetric collection method to measure and evaluate the global (i.e. monolith) scale distribution. The assessment is done using a *Distribution Index*, which is assessed for a variety of flow conditions. For selected distributors, further investigation has been performed by changing the liquid phase properties. The study has been conducted for different monolith geometries. To investigate hydrodynamics inside channels of the monolith, an optical probe technique has been used. The optical probes have been positioned at pre-selected channel positions for distributors selected from the above "macro-scale distribution study." This study provides insights into the local flow pattern inside channel, which is in turn dependent on the macro-scale gas-liquid distributor.

सार

प्रस्तुत अनुसंधान में विविध तरल–वितरकों से (gas-liquid distributor), विविध परिस्थितियों में, समवर्ती डाउनफ्लो मोनोलिथ रिएक्टरों में होने वाले गैस–तरल द्रव्य के वितरण पर संशोधन किया गया है. रिएक्टर एवं वाहिका–स्तर में होने वाला गैस–तरल द्रव्य वितरण, त्रि–प्रावस्था मोनोलिथ (three-phase monolith) रिएक्टरों की क्षमता को प्रभावित करनेवाला एक अविभाज्य गुणक होता है. ऐसा प्रमाणित हुआ है कि वितरण व्यवस्थित रीति से ना होने पर, त्रि–प्रावस्था मोनोलिथ रिएक्टरों की कार्यक्षमता उच्च उत्प्रेरक–प्रक्रिया के बावजूद भी उल्लेखनिय ढंग से घटती है. इसके व्यतिरिक्त रिएक्टर–स्तर पर होनेवाला व्यापक गैस–तरल द्रव्य वितरण भी प्रत्येक वाहिका में होने वाले स्थानीय सिंचन की व्यापकता को प्रमाणित नहीं करता है. इस अनुसंधान कार्य में इन दोनों पहलुओं को विषद किया गया है.

इस संशोधन में विविध प्रयोगशालेय तरल–द्रव्य वितरकों से मोनोलिथ रिएक्टर में मोनोलिथ–स्तर पर होने वाले वितरणको भारात्मक संग्रह पद्धति (Gravimetric collection method) से जांचा गया. इन जांचो को "वितरण–सुचनांक" (Distribution Index) के स्वरूप में विविध प्रवाह परिस्थितियों में मूल्यांकित किया गया. चुनिन्दा वितरकों के लिए तरल द्रव्य के स्वभाव को बदलकर अधिक विस्तारपूर्वक जांच की गई. यह अभ्यास विविध मोनोलिथ भूमितियों के लिए संचालित एवं स्थापित किया गया. वाहिकाओ में होने वाले द्रव–गति–प्रक्रियाओं (hydrodynamics) को जांचने के लिए ऑप्टिकल–प्रोब पद्धति (Optical probe technique) अपनाई गई. यह ऑप्टिकल–प्रोब व्यापक वितरण अभ्यास से चुने गए वितरकों के लिए वाहिकाओं में पूर्वनिश्चित स्थानों पर स्थापित किया गया. यह संशोधन वाहिकाओं में रचित होने वाले प्रवाह-व्यवहार के बारे में अंतर्दृष्टि प्रदान करता है जो स्वयं ही व्यापक–स्तर गैस–तरल द्रव्य वितरको पर अवलंबित है.

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