CHAPTER - 5

SCALE DEVELOPMENT

5.1 OVERVIEW

Pigging operation is one of the most prominent concepts in the literature and in short, and indicates the utilization of pipeline inspection gauge tool and its positive impact in the pipeline operation and performance. Despite limited growing body of literature on this concept, the theory & application of multiphase pigging operation is still problematic. Although the literature provides several complicated theories of multiphase flow and pigging operations with simplified solutions through assumptions almost all them have some or other limitations. The purpose of this study is to provide an original, valid, and reliable measure of the innovative solution developed in this research study reflecting the difficulties and impacts.

Based on a proposed conceptual framework of pigging operation, a scale was developed through the systematic scale development process. In the study exploratory factor analysis was conducted to determine the underlying factorial structure of the scale. Data was collected from around 40 number of pigging tests carried out in the offshore oil field. The results of the analysis provided a three dimensional structure/model of by-pass pigging which can be solved with help of mass, momentum and energy conservation equations.
5.2 TECHNOLOGY READINESS LEVEL SCALE

The TRL scale was developed to enable assessment of the maturity of a particular technology and the consistent comparison of maturity between different type of technologies. TRL helps to assess which stage of development a technology is in. This is a systematic approach to communicate the readiness of technology and forecast implementation between technological research and forecast implementation between the technological research and the mission planning community.

9 levels of Technological development method followed by US DoE is commonly adopted in the Oil Industry. Following are these 9 levels:

1. Basic principles observed
2. Technology/concept application formulated
3. Experimental Proof of concept
4. Component/system validation in lab environment
5. Validation in relevant environment
6. Pilot scale validated in relevant environment
7. Full scale demonstration in relevant environment
8. System complete and qualified(test and demonstration)
9. Actual system operated at full range conditions

In this research work a similar scale of technological development is followed.

5.3 OPERATIONALIZATION OF RESEARCH MODEL’S COMPETENCE

A very important step throughout the study of multiphase flow is the need to model and predict the detailed behavior of those flows and the phenomena that they manifest. There
are three ways in which such models are explored: (1) experimentally, through laboratory-sized models equipped with appropriate instrumentation, (2) theoretically, using mathematical equations and models for the flow, and (3) computationally, using the power and size of modern computers to address the complexity of the flow. Clearly there are some applications in which full-scale laboratory models are possible. But, in many instances, the laboratory model must have a very different scale than the prototype and then a reliable theoretical or computational model is essential for confident extrapolation to the scale of the prototype. There are also cases in which a laboratory model is impossible for a wide variety of reasons. In the cases of pigging operations of long distance pipelines this is very obvious. Consequently, the predictive capability and physical understanding must rely heavily on theoretical and/or computational models and here the complexity of most multiphase flows presents a major hurdle. It may be possible at some distant time in the future to code the Navier-Stokes equations for each of the phases or components and to compute every detail of a multi-phase flow, the motion of all the fluid around and inside every particle or drop, the position of every interface. But the computer power and speed required to do this is far beyond present capability for most of the flows that are commonly experienced. When one or both of the phases becomes turbulent (as often happens) the magnitude of the challenge becomes truly astronomical. Therefore, simplifications are essential in realistic models of most multiphase flows.

5.4 SUMMARY
In this research project theoretical models of the new profile is designed and developed. Based on the simulations & initial design calculations laboratory experimental models and prototypes were fabricated and experiments were conducted in the laboratory for various nozzle and throat combinations of convergent divergent nozzle profiles. The profiles were
tested at various pressure conditions in the laboratory. After finding favorable results actual profiles were fabricated and field tested in a bigger scale in the field at actual field conditions.