# EXECUTIVE SUMMARY

The trigger for this research was to develop process model for Dehydration and Desalting Process (DDP) that may be used at oilfield plant to simulate various operating scenarios in order to support decisions for optimizing plant's operation.

For building such model, I have utilized the concept of Artificial Neural Network (ANN). This technique allows to correlate performance of a process with various process parameters of interest, in a generalized manner, through black-box modelling, which otherwise could be complex and specific to a particular equipment design if first-principles model is built. Further, to reap the benefit of ANN model's generalization capability, to extend its application beyond modelling DDP, and to maximize its versatility and outreach, I implemented the ANN model in MS Excel. Thus, I achieved a versatile process model (named VP Model), that is, a modelling framework which may be populated, trained, tested and used as a model-based decision support tool at any plant where large amount of data is present.

Two different problems of modelling of DDP were considered to utilize the developed modelling framework mentioned above:

1. Two models, correlating the performance of DDP, measured as Salt Removal Efficiency (SRE) or Water Removal Efficiency (WRE), with 5 process variables representing common operating factors namely heating, chemical dosing, dilution, mixing, and gravity settling were implemented. Output of each model was compared with respect to two sets of known data namely Training Data and Testing Data. $R^2$ values were found encouraging. Further, each model's output was also compared with output of ANN implemented through MATLAB's corresponding to both Training as well as Testing Data sets; $R^2$ values were found encouraging. Thus, it is demonstrated that:

a) ANN model can be used for modelling performance of a process dependent upon various parameters in a complicated manner, firming the previous finding.

b) ANN model can also be implemented in widely available MS Excel, in contrast to many previous process modelling attempts through ANN, which utilized special codes / package like MATLAB.

2. A DDP model for estimating wash water flow rate for given crude production flow rate (barrel per day i.e. bbl/day), inlet temperature ($^{o}$F), inlet and outlet salt content (ppm) and chemical dosing rate (bbl/day) was implemented to demonstrate the versatility of the attained modelling framework (i.e. VP Model). Output of this model was compared with respect to two sets of known data namely Training Data and Testing Data; $R^2$ values were found encouraging.

Applications of the developed modelling framework (VP Model) for process simulation and optimization and linking with Aspen Hysys have also been demonstrated in this thesis.

From the above, it is inferred that:

*i.* *The developed modelling framework (VP Model) may be populated, trained, and continually updated for various operating parameters of interest for different DDPs irrespective of their different design / construction for using it as a model-based decision support tool for optimizing plant operations.*

*ii.* *The model may be coupled with widely used proprietary process simulation softwares like Aspen Hysys (which does not contain direct modelling provision for DDP) that allow input /output interface with Excel.*

*iii.* Though versatility of the model was demonstrated in reference to DDP, but it may be utilized as a versatile process model (named VP Model) to correlate any 5 independent process variables to any dependent variable for a given data set. *Thus, it can serve as a*

*fundamental tool / framework for further process studies and development even beyond the realm of DDP.*

As the model is built in MS Excel, it makes possible for a user *to access and further use* the implicit relationship between dependent and independent variables in numerous ways.

iv. The model may be customized for different applications by end users without having any specialized computer program coding skills or advanced mathematical skills.

v. The model may be utilized to demonstrate the concept and application of ANN, in general, and MLP in particular, for education, as a short course. Simple implementation in Excel allows user to develop clarity about the underlying concepts unlike other software packages developed using software code.

vi. The model does not require expensive software license other than what is generally available in any computer in industries and academic / research institutions.

vii. The model may help promoting ANN as a general tool for researchers / scholars.

viii. *The model may be utilized for accomplishing model-based decision support for variety of applications.* For example, it may be utilized by process engineers at any process plants to suggest plant's operations, in optimized manner, by predicting plant's performance under different operating scenarios.

ix. *The model may supplement advanced softwares in order to avail numerous* benefits, like to save expenditures on computation power (e.g. usage license) and time (taken by advanced software to access license each time it is opened and to converge each time any parameters are varied) and prevent wastage of resources (in view of reluctance in using advanced simulation software by operational staff). Advanced software may be used to determine optimal ANN configuration and to generate accurate and sufficient data for the desired operational range to train such model.

In short, the model may easily be adapted for variety of chemical engineering applications, for industrial and /or academic needs, especially, pertaining to process modelling, simulation and optimization as well as process control. Further research may be conducted to implement the model in real-time optimization to avail benefits from its potential time saving feature mentioned above.