Development of Corrosion Prediction Analytics Engine Exploiting ANN and GA

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***Abstract*:- The main aim of the project is to develop an website for the benefit of the petroleum companies. Nowadays the companies are willing to have a knowledge of the corrosion occur in the transmission pipelines. But there is no way to predict the accurate corrosion time period so the companies face saviour loss in the transmission. To overcome this problem, an website is developed to calculate the corrosion timeperiod of the pipeline to yield a profit of the companies. It helps the companies to identify the correct time period of corrosion takes place in the pipeline and helps us to find the life cycle coasting of the pipelines.At the same time, it also ensures the previous years corrosion rate with the present rate of the corrosion. Firstly, carbon steel erosion strength model is proposed based on decision tree as we have mentioned above. Secondly the data which are obtained are feed into the excel to analyse the performance. Finally the graph of the Life cycle costing is gained with the help of power BI. The Life Cycle Costing explains the time period of the corrosion takes place and it intimate the company authorities to change the corroded pipeline.**

1. INTRODUCTION

In recent years, with the increase of the proportion of inferior crude oil processed in the oil refining industry, a large number of flow corrosion failure appear in petrochemical plant, such as in pipeline and air cooler system which seriously affect the safety and economic benefits of the enterprise. In refinery acid water system, the erosion is the main failure form of pipeline corrosion. Carbon steel, as the pipe material often used, whose real time corrosion strength and corrosion rate are related to real time operating conditions: temperature, shear stress, and NH_4HS concentration, Cl concentration, H_2S partial pressure, etc. If we can get the quantitative relationship among the corrosion strength and corrosion rate of carbon steel and other influence factors above, safety of the whole acid water system can be evaluated and operation of the system can also be adjusted in a more reasonable way. However in the acid water system, as carbon steel corrosion is dependent upon a lot of numbers of corrosion state variables and there are complicated coupling relationships among these variables, it is difficult to establish an accurate analytical model.

At the same time, with the continuous accumulation of historical data, in many industries, including corrosion prevention and control, more and more data mining algorithm is applied to a variety of patterns mining or prediction. Due to the characteristics of strong explanatory and easy calculation, decision tree has obtained a lot of applications. Gu[1] proposed a pipeline integrity assessment method based on a combination of decision tree and probability algorithm (POE). Chawla[2] proposed chemical state map and diagnosis decision tree based on the analysis of the corrosion product data. Yehia[3] proposed a maintenance method for concrete bridge deck corrosion. King [4] proposed an evaluation method based on decision tree for the microbial corrosion in nuclear waste container. Meanwhile, artificial neural network as an effective modeling tool, are also widely used in all kinds of state prediction in industry.

ZareNezhad[5] proposed a dew point prediction model of multi-layer feedforward neural network for sulfuric acid Earth alloys corrosion mechanism based neural network. Concerning the problem of carbon steel erosion corrosion in sour water system, there are some needs of complete predictive model for carbon steel erosion corrosion both in strength and rate. In this paper, firstly, carbon steel erosion strength model is proposed based on decision tree as we have mentioned above. Secondly the data which are obtained are feed into the excel to analyse the performance. Finally the graph of the Life cycle costing is gained with the help of power BI.

The major advantages of developing a desktop application are listed below:

- Cross platform – HTML runs on all operating systems, so it can be much easier to create across platform desktop application.
- Window sizing and control – If the app is to be run at a certain size, or made to do some more advanced things with popup, the controls are got on the desktop. Most solutions also provide a way to access the file

system and allow other more advanced controls that can't be got with a regular web app.

- Build once, run everywhere – Many applications can see a huge benefit to sharing code between the desktop, web and mobile space.

2. LITERATURE REVIEW

2.1 EXISTING SYSTEM

There are many companies which do not care for the corrosion in the pipeline as the result of that many of the companies face a major loose in their yearly turnover. To reduce the loose and to increase the profit all petroleum companies developed an software to predict the time of the corrosion. In those software's the data are entered manually and the result gain is appropriate.The existing softwarepresents a hierarchical approach to assess system corrosivity and facilitates prediction of corrosion rates for carbon steels in production / transmission environments containing CO2 and/or H2S. Based on user input data, Predict captures the effects of key critical environmental and operating parameters that influence corrosivity. It further characterizes the effects of these parameters on corrosion rates, utilizing extensive laboratory data, phase behavior models and fluid dynamic characterization.

Features

Predict provides a practical prediction of system corrosivity for carbon steel based on available operational parameters. This enables informed financial and engineering decisions built on real material performance data. Predict offers several unique attributes:

• A corrosion prediction system to provide a way to estimate probability of pitting
corrosion
• The ionic, pH computation module accounts for the effects of 16 different anion
and cation species,
• Rigorous water phase behavior calculations coupled with the ability to account
for the effects of glycol (MEG, TEG and DEG)
• Ability to accurately model momentum transfer effects (flow regimes, void
fractions, pressure drops and shear stresses)
• Ability to accurately determine scaling effects due to formation of iron
carbonate and iron sulfide scales as a function of
temperature and pH
• Ability to accurately characterize role of oxygen concentration in corrosive
systems
• Improved rules to account for variation of water content in oil and gas systems
(production and transmission)
• Quick access to actual laboratory test data encompassing over 18 flow loop tests
• Accurately determine scaling effects due to formation of iron carbonate and
iron sulfide

2.1.1 DISADVANTAGES OF EXISTING SYSTEM:

- Existing system is not user interactive.
- Lack of cooperation.
- Weak communication status.
- Lack of communication and participation among the members.
- Absence of common brands.
- Old traditional business activities.
- Middlemen makes excessive profits.

2.2 Proposed System

The proposed system utilizes a website (HTML) and android based client in the front end and server pages running at server side accessing MYSQL database in the back end. The system facilitates multiple user login for both farmers and the end users. All the login details are stored in the database. The data that are sent are stored in the centralized cloud database. The advantage of this system is that it is very user friendly. The use of a corrosion modeling application like Predict allows a company or site to evaluate corrosion problems consistently and with high accuracy and repeatability.

Predict is built upon a multifaceted, foundation of corrosion knowledge, including proprietary data from hundreds of laboratory tests that constituted a Joint Industry Project (JIP) on Multiphase CO2/H2S corrosion extensive literature information, accurate multiphase flow modeling and the industry's most comprehensive database on steel corrosion rates. Because corrosion in multiphase CO2 and H2S systems is an extremely complex phenomenon, the only way to model corrosion is to utilize laboratory test data generated under simulated flowing conditionsThe JIP corrosion test conditions incorporate simulated flowing conditions and that data helps in formulation of rules correlating critical parametric relationships. Predict also incorporates rigorous mechanistic models for phase behavior, ionic analyses and flow modeling. This integration of first principles and real engineering data provides Predict the unique foundation to accurately predict corrosion under a range of operating conditions relevant to oil and gas production and transmission systems. The result is that Predict is the only system available today whose numerical model is built upon real H2S and CO2 corrosion laboratory testing data integrated with rigorous flow and ionic modeling.

New Enhancements

• New pH prediction module that facilitates accurate inlet and outlet
condition characterizations

- Accurately determine scaling effects due to formation of iron carbonate and iron sulfide
- Perform advanced flow modeling and correlate wall shear stress effects on corrosion rate from JIP data
- Perform prediction from aqueous CO2 / H2S corrosion data
- Characterize water phase behavior from specified dew point
- Perform life cycle cost analysis and graphically view of service life of pipe from predicted time to failure plot
- Evaluate entire pipeline profiles with horizontal, vertical or inclined segments
- Perform Multi-Point Analyses, Multi-Point Sensitivity Analyses and Expert Multi-Point Sensitivity Analyses
- Exchange data seamlessly with other Honeywell Corrosion Models

ADVANTAGE OF PROPOSED SYSTEM

- Evaluate and Predict corrosion for a variety of corrosive environments with acid gases - production, pipelines, power plants, flow lines, gas processing plants
- Accurately calculate operating system in-situ pH with data on system chemistry
- Evaluate CO2/H2S corrosion and other parametric interactions
- Predict phase behavior of water in aqueous systems
- Determine the flow behavior and accurately correlate the flow effects
- Graphically view the corrosion profile over an entire pipe / tubing length
- Predict corrosive effects of systems with chlorides, oxygen or sulfur
- Perform comprehensive corrosion and cost characterization for entire systems

3. PROPOSED SYSTEM

3.1 OVER VIEW

The primary motto of this project is to create an web application to predict the corrosion time period of an pipeline which is used to carry petrol and other petroleum substances which will reduce the maintenance cost and earn some profit to the company which earns that. This application is made more effective as desktop application with the advantage of user friendly power BI software present in it. Power BI instantly convert the data into graph for the type we needed.

3.2 SYSTEM DESIGN

In this project a website had been design for the prediction of corrosion occur in the certain time period in an petrol carrying pipeline in advance. This application makes use of client-server communication.

As the second step the software will import the data from the excel sheet and it displays the graph of the chemical level present in the pipeline.The admin can able to view or can able to download the graph for the data recordings. The total working of the software is diagrammatically represented in architectural diagram fig 3.1.

3.1.Architectural Diagram

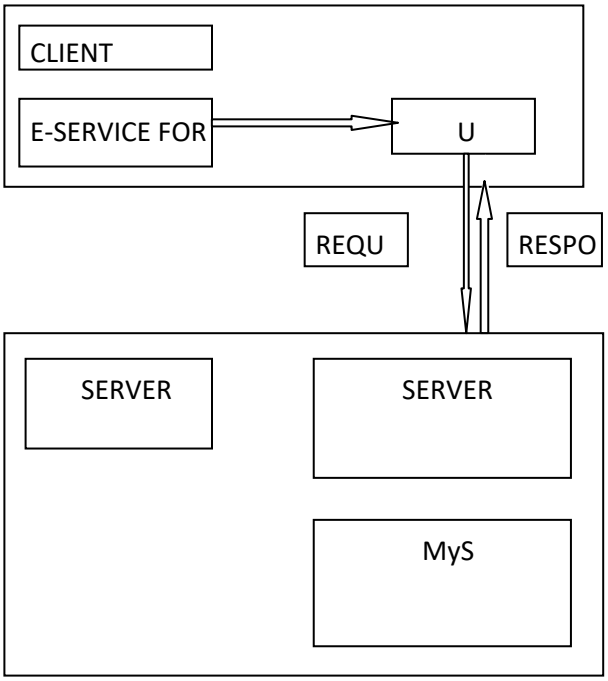

Figure 3.1 Architectural Diagram

The total working of the software system is shown as the sequential diagram in the figure 3.2. The sequential diagram consist of the three modules Interface, Local system and Server side modules. Each had specific role and they are the most important element in the corrosion prediction analytic engine.

3.3.SEQUENTIAL DIAGRAM

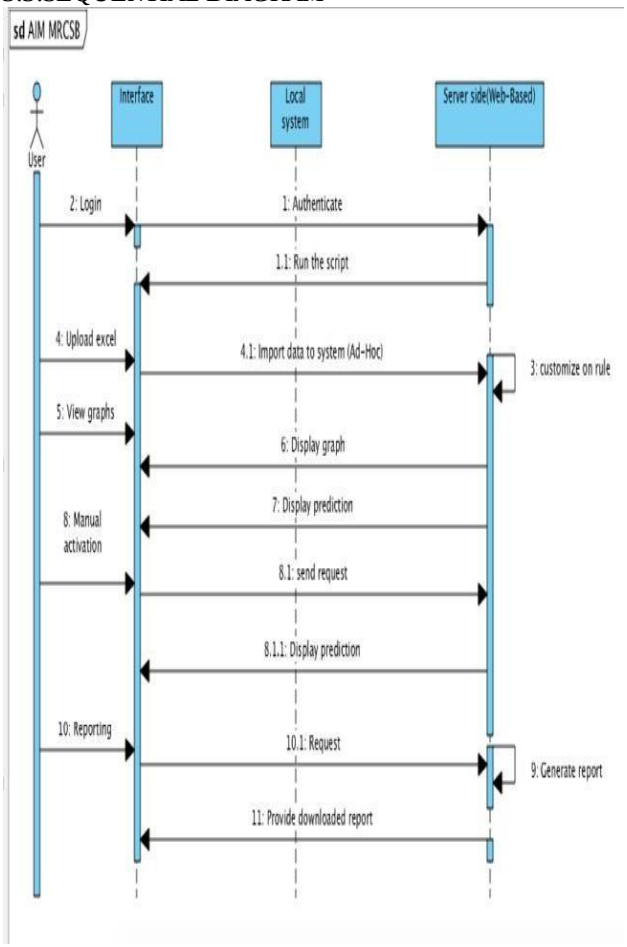

Figure 3.2 Sequential Diagram

***3.4** MODULES DESCRIPTION*

***3.4.1** Register Module*

This module consists of creating accounts for the respective user. The user should fill the details based on the account type. This detail is then updated in the database. The logout option helps user to leave the application.

***3.4.2** Login Module*

The user must log in using the authentication credentials. Login module has a centralized database with integration to multiple components for processing user information. The login web service returns if the user is a farmer or end user. The home screen is displayed as per the response.

3.3.3 User Module

The Database Design describes about the data field used in the admin page. The database design schema of the system is shown in 3.4. These system are mainly used in the authentication of the user in the admin page.

DATABASE DESIGN SCHEMA

User signup table

Field	Data type	Null	Description
Uid	Int(20)	No	Primary key-user id
Name	Varchar(20)	No	Name of the user
Gender	Varchar(20)	No	Gender of the user
Email_id	Varchar(20)	No	Email id of the user
Password	Varchar(20)	No	Password for user account
Confirm_password	Varchar(20)	No	Confirm password for user account
Phone_number	Int(10)	No	User-phone number

Figure 3.4 Database Design Schema

4.SYSTEM IMPLEMENTATION

***4.1** INPUT DESIGN*

Input design is one of the most expensive phases of the operation of mobile system and is often the major problem of a system. A large number of problems with a system can usually be traced back to fault input design and method needless to say, therefore that the input data is the life block of system and has to be analysed with the most consideration.

The decisions made during the input design are:

- To provide the cost-effective method of input.
- To achieve the highest possible level of accuracy.
- To ensure that input is understood by the user.

System analyst decide the following input design like, what data item to input, what medium to use, how the data should be arranged or coded data items and communication needs validation to detect errors and at last the help activity to guide users in providing input.

Input design is the process of converting user- originated inputs to a computer based format. Input data are collected and organized into a group of data which are similar. The goal of designing input data is to make communication much easy and make error free as far as possible.

***4.2** OUTPUT DESIGN*

Output design generally refers to the data reliability of the communication through WiFi, the authorized user can only be communicated, timely deliver is required and the authentication is provided for each users. For

many end-users , Output is the main reason for developing the system and on which they evaluate the usefulness of application. The user of the output, its purpose and sequence of details to be printed is all considered. The output from a system is the justification for its existence. If the output is inadequate in any way, the system itself is inadequate. The output should be accurate, timely and appropriate in terms of content, medium and layout for its intended purpose.
When designing output, the system analyst must accomplish things like, to determine what information to be present, to decide whether to display or print the information and select the output medium to distribute the output to intended recipients. External outputs are those, whose destinations will be the organization and which require special attention. The GUI oriented output is generated in this project.

4.3 TESTING

Testing is the process of trying to discover every conceivable fault or weakness in a work product. It provides a way to check the functionality of components, sub-assemblies, assemblies and/or a finished product. It is the process of exercising software with the intent of ensuring that the Software system meets its requirements, user expectations and does not fail in an unacceptable manner. Each test type addresses a specific testing requirement.

4.3.1 Unit Testing

Unit testing involves the design of test cases that validate the internal program logic is functioning properly, and that program inputs produce valid outputs. All decision branches and internal code flow should be validated. It is the testing of individual software units of the application. It is done after the completion of an individual unit before integration. Unit tests perform basic tests at component level and test a specific business process, application, and/or system configuration. Unit tests ensure that each unique path of a business process performs accurately to the documented specifications and contains clearly defined inputs and expected results. Tests were conducted separately for back end and front end Android client. Different test cases were prepared by the testing team for various classes and functions and a detailed bug report was sent and the bugs were cleared.

4.3.2 Integration Testing

Integration tests are designed to test integrated software components to determine if they actually run as one program. Testing is event driven and is more concerned with the basic outcome of screens or fields. Integration tests demonstrate that although the components were individually satisfied, as shown by successfully unit testing, the combination of components is correct and consistent. Integration testing is specifically aimed at exposing the problems that arise from the combination of components. The integration testing was performed after linking both the server side and the Android client.

4.3.3 Functional Testing

Functional test provide systematic demonstrations that functions tested are available as specified by the technical requirements, system documentation, and user manuals.
Functional testing is centerd on the following items:
Valid Input : identified classes of valid input must be accepted.
Invalid Input : identified classes of invalid input must be rejected.
Functions : identified functions must be exercised.
Output : identified classes of outputs must be exercised.
Procedures : interfacing system or procedures must be invoked.
Systematic coverage pertaining to identify data fields, predefined processes and successive processes must be considered for testing. Before functional testing is complete, additional tests are identified and the effective value of current tests is determined.

4.3.4 Acceptance Testing

User Acceptance Testing is a critical phase of any project and requires significant participation by the end user. It also ensures that the system meets the functional requirements.The users were satisfied with the web cum mobile application and have accepted it. Test Results: All the test cases mentioned above passed successfully. No defects encountered.

5. CONCLUSION AND FUTURE WORK

5.1 CONCLUSION

Software have become common and have increased the accessibility of people to technology. Like wise this software helps the petroleum industry to reduce its cost of loss caused by the corrosion in the pipeline. This software predicts the corrosion point with the help of user provided data and intimate the corrosion point of the pipeline previously to the user or the company authority. With the help of this software one can easily find the corrosion point of the pipeline and compare the corrosion rate of the pipeline to its previous year.

5.2 FUTURE WORK

Today, more and more people use the internet. Websites have become common and have increased the accessibility of people to technology. Android platform and use of it in the smartphone is the growing technology in the modern world.In future it is planed to make the website as an mobile application since if we being the whole website in an app it will be more use full to the

company higher authorities because instead of single person monitoring the pipeline if several person monitors it then the failure rate will be reduce and the company's profit will get increased.

REFERENCES

1. https://books.google.com.my/books?id=CyjMBQAAQBAJ&pg=PA141&lpg=PA141&dq=existing+system+in+corrosion+predictions&source=bl&ots=WGdgTKn_9b&sig=4ObC79cNiOS73udwgL783DwOmdQ&hl=ta&sa=X&ved=0ahUKEwjv5YWXzLPZAhWBLI8KHfxhDfgQ6AEITDAF#v=onepage&q=existing%20system%20in%20corrosion% 20predictions&f=false
2. Prediction of the laws of carbon steel erosion corrosion in sour water system based on decision tree and two kinds of artificial neural network model - IEEE Conference Publication
3. https://www.sbir.gov/sbirsearch/detail/3578 93
4. https://www.sbir.gov/sbirsearch/detail/3578 93
5. IEEE Xplore Full-Text HTML : Petrochemical equipment corrosion prediction based on BP artificial neural network
6. http://ieeexplore.ieee.org/document/5777001/media
7. Prediction of the laws of carbon steel erosion corrosion in sour water system based on decision tree and two kinds of artificial neural network model - IEEE Conference Publication
8. Petrochemical equipment corrosion prediction based on BP artificial neural network - IEEE Conference Publication
9. A corrosion prediction model for oil and gas pipeline using CMARPGA - IEEE Conference Publication
10. Reinforcement in Concrete Based on ANN - IEEE Conference Publication
11. Quickcat: The Design and Implementation of a Corrosion Analysis Automation Tool - IEEE Conference Publication