UNIVERSITY OF ALBERTA
DEPARTMENT OF CHEMICAL
& MATERIALS ENGINEERING

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2016 IRC WORKSHOP ON

PROCESS SYSTEMS ENGINEERING AND CONTROL

Date: Thursday, Feb 25, 2016

Time: 8:00 AM – 3:00 PM

Venue: ETLC Solarium, University of Alberta

Sponsors: NSERC, AITF, Suncor, Syncrude, University of Alberta

Sample Research Results by NSERC Industrial Research Chair in Control of Oil Sands Processes and AITF Industry Chair in Process Control.

TIME	TOPIC	SPEAKER
8:00 – 8:30 AM	*General registration open; Cookies & coffee for external attendees*	
8:30 – 8:35 AM	Introduction, safety	• Biao Huang
8:35 – 8:45 AM	Opening remarks	• Fraser Forbes (UofA), • Dan Brown (Syncrude), • Eric Lau (Suncor)
8:45 – 9:15 AM	Steam Generation Network Optimization with Application	• Rishik Ranjan
9:15 – 9:45 AM	Emulsion Flow Soft Sensor with Application	• Ruomu Tan
9:45 – 10:15 AM	Sulfur Content Soft Sensor with Application	• Hariprasad Kodamana
10:15 –10:45 AM	*Coffee Break*	
10:45 –11:15 AM	N2B Soft Sensor with on-line Inferential Control	• Shekhar Sharma

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11:15 –11:45 AM	New Development in Steam Quality Soft Sensor for Steam Generators	• Yanjun Ma
11:45 –12:15 PM	System Performance Monitoring and Diagnosis - Plant-wide Optimality and Safety Assessment	• Shabnam Sedghi
12:15 – 1:15 PM	*Lunch and discussion, closing remarks, end of workshop.* *(Buffet lunch by invitation only)*	
12:40 –12:50 PM	System Performance Monitoring and Diagnosis – Early Fault Detection Brief	• Rahul Raveendran
12:50 – 1:00 PM	Summary	• Biao Huang
1:00 –1:15 PM	Closing Remarks	• Suncor, Syncrude
1:15 – 3:00 PM	*Afternoon session for IRC partners @* 7-395 ICE Building	
1:15 –1:45 PM	Introduction and update of IRC renewal	• Biao Huang
1:45 –3:00 PM	New partner introduction, research direction, general discussion, Q&A	• All partners

Contact:

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Parking Map:

Windsor Car Park

Venue Map:

ETLC Solarium, University of Alberta

Continue to the next page for abstracts of all presentations.

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Steam Generation Network Optimization with Application

Researcher: Rishik Ranjan

Utilities such as steam play an important role in several process industries. Supply or demand for a utility may change over time due to unforeseen or planned changes in operating constraints. In the case of steam generation systems which consist of several steam generator and water treatment units, buffer tanks are used to mitigate the effect of such changes. It is important to ensure buffer tanks are used efficiently to ensure safe operation. Another aspect that governs operation decision making is economic optimization. Operators would like to have a tool which can provide an optimal operating strategy.

To address this problem, a GUI based application has been developed for performing data reconciliation and optimization for steam generation networks. The application is built on Excel and uses GAMS for solving the optimization problem. Besides optimization, the data reconciliation feature allows operators to close the mass balance across the site and estimate missing flow measurements.

The application has been tested on a SAGD steam generation network. Results suggest that the proposed application can be used to find safe and optimal operating points. The GUI interface offers users the freedom to choose their constraints and modify optimization objectives as required.

Emulsion Flow Rate and Water Content Soft Sensor

Researcher: Ruomu Tan, Yanjun Ma

In a typical well pair of Steam Assisted Gravity Drainage (SAGD) process for producing bitumen, hot and high pressure steam is injected through the injection well to the oil sands reservoir. With the viscosity of bitumen reduced by the injected steam, a mixed flow of bitumen, water and gas is pumped out through the producer well. Emulsion flow, which represents a mixture of bitumen and water, is considered to be the main product of this procedure.

As key variables for control and optimization of subsequent operations, the flow rate and water content of produced emulsion fluid of individual well pairs are of great interest. However, hardware fast-rate sensors measuring these variables are expensive and hard to implement. Therefore, two types of soft sensors based on inferential models for predicting the emulsion flow rate and its water content are built

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respectively, by using easy-to-measure process variables in order to obtain granular and accurate predictions. The inferential models can be trained and validated through historical data sets from different well pairs. In addition, due to the redundant information of overall flow rate measurement, an online data reconciliation strategy can be applied to further improve the performance of flow rate soft sensors. The flow rate soft sensor with robust layer and online data reconciliation functions has been used for advanced control.

Sulfur Content Soft Sensor with Application

Researcher: Hariprasad Kodamana

The presentation focuses on sulphur content soft sensors for Heavy Gas Oil (HGO) hydrotreator plants for Oil Sands upgrading process. Sulphur content is an important quality variable that must be measured. However, the lab sampling is usually infrequent, so the proposed soft sensor is envisaged to provide continuous prediction of the sulphur content. Based on an extensive study of upstream processes, possible process variables, which may have direct impact on the sulphur content, are selected. A soft sensor is developed considering the above variables and the testing results demonstrate that the developed soft sensor has significant improvement in its performance.

N2B Soft Sensor with on-line Inferential Control

Researcher: Shekhar Sharma

In this presentation, we demonstrate the successful completion of a soft sensor project cycle, from the initial model identification step to the final step of closed loop control implementation based on the soft sensor. The application concerns predicting the N:B (naphtha: bitumen) ratio in the feed stream to the IPS (Inclined plate separator), which is an important step in the extraction process to separate bitumen from water and solids. Naphtha is added to the IPS feed to enhance the density difference between the feed components and aid in the separation process. The N:B ratio is a key variable, and the naphtha flow is regulated to maintain it at an optimum level to ensure effective extraction of bitumen in a cost efficient manner. However, this quality variable is not available on demand and is usually determined through laboratory analysis, and therefore the aim of this application is to provide reliable and more

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accurate fast rate prediction of N: B to be used for closed loop control. In the presentation, we will discuss the offline modeling and validation, the online open loop implementation and testing, and finally, the closed loop implementation and the subsequent improvement achieved. The challenges at different stages of the project will be discussed, along with the lessons learnt through this implementation.

New Development in Steam Quality Soft Sensor for Steam Generators

Researcher: Yanjun Ma

Mixture of heated water and steam constitutes an indispensable part for both of the open-pit extraction and the in-situ recovery. Motivated by the objective of minimizing water and energy consumption, steam generators, such as Heat Recovery Steam Generator and Once Through Steam Generator are expected to be controlled efficiently. The steam quality soft sensor, serving as an estimator of the steam-water ratio of the produced fluid, is able to provide enough granular measurements for control and optimization purposes.

In previous works, the soft sensor generated from the heat balance model, as well as corresponding parameter estimation and online updating techniques are developed to predict the steam quality at individual passes in a steam generator. However, in other scenarios, challenging problems may be encountered in the availability of previously required process variables. In this presentation, new developments, along with its successful industrial implementations consisting of variants in the energy balance model and optimization with respect to the differential pressure model, will be discussed.

Plant-wide Optimality and Safety Assessment

Researcher: Shabnam Sedghi

Safety and optimality of processes are two important issues in industry. Operating performance of industrial processes may deviate from the initial design over time due to process characteristic variation such as changes in process conditions, different product demands, etc. This will decay the benefits of the original optimal and safe designs. Thus, it is necessary to develop a tool for online operating performance assessment based on both safety and optimality. In this presentation, plant-wide

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optimality and safety assessment for multi-mode operating processes will be discussed. In the first part of this presentation, the proposed method is introduced, and in the second part, an example of testing this method on a water treatment network plant is described.