SUPPORT VECTOR MACHINE-BASED SOFT SENSORS IN THE ISOMERIZATION PROCESS

Srečko Herceg, Željka Ujević Andrijić, Nenad Bolf

University of Zagreb, Faculty of Chemical Engineering and Technology, Department of Measurements and Process Control, Savska c. 16/5a, 10 000 Zagreb, Croatia

FKITMCMXIX

ABSTRACT

The development of soft sensors based on support vector machine (SVM) is presented. The SVM method is based on the statistical learning theory and is widely used for soft sensor model development. Developed models will be utilized for continuous estimation of important product component contents in the refinery isomerisation equipped with a deisohexanizer distillation column.
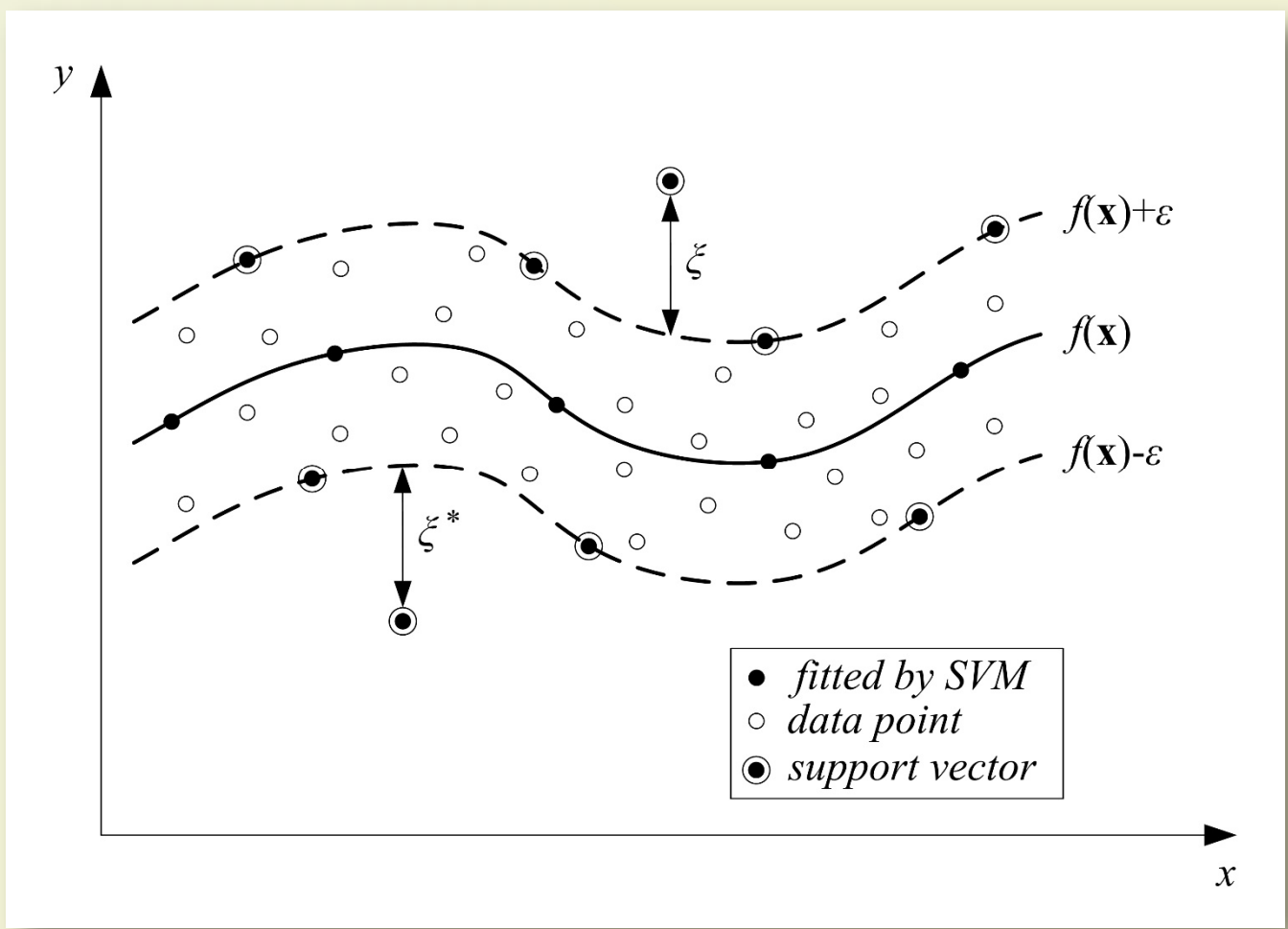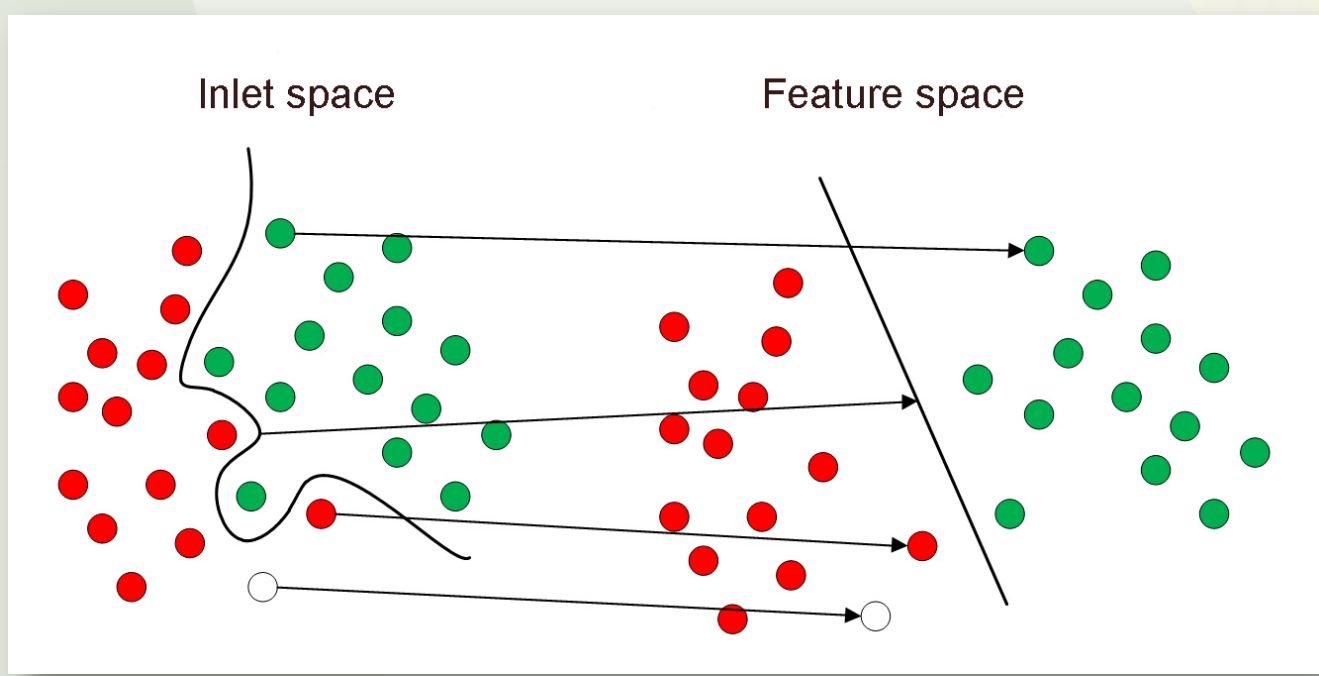
During the model development selection and preprocessing of the experimental data have been critical steps. Evaluation of the developed models on an independent data set showed their reliability in estimating the component contents. Developed soft sensors can be applied as analyser replacements as well as in the advanced process control strategies.

CONCLUSION

Continuous measurement of key process variables is necessary for today's petroleum industry. It is reflected through the requirements for a continuous improvement in a product quality and in minimizing energy consumption.

Soft sensor models based on SVM for continuous estimation the content of 2,3-DMB and 2-MP as one of the key components in the products of the refinery isomerization process equipped with a deisohexanizer column are developed. The models describe the process dynamics very well and therefore are suitable for the application in the isomerization process plant, especially as an alternative to expensive process analysers.
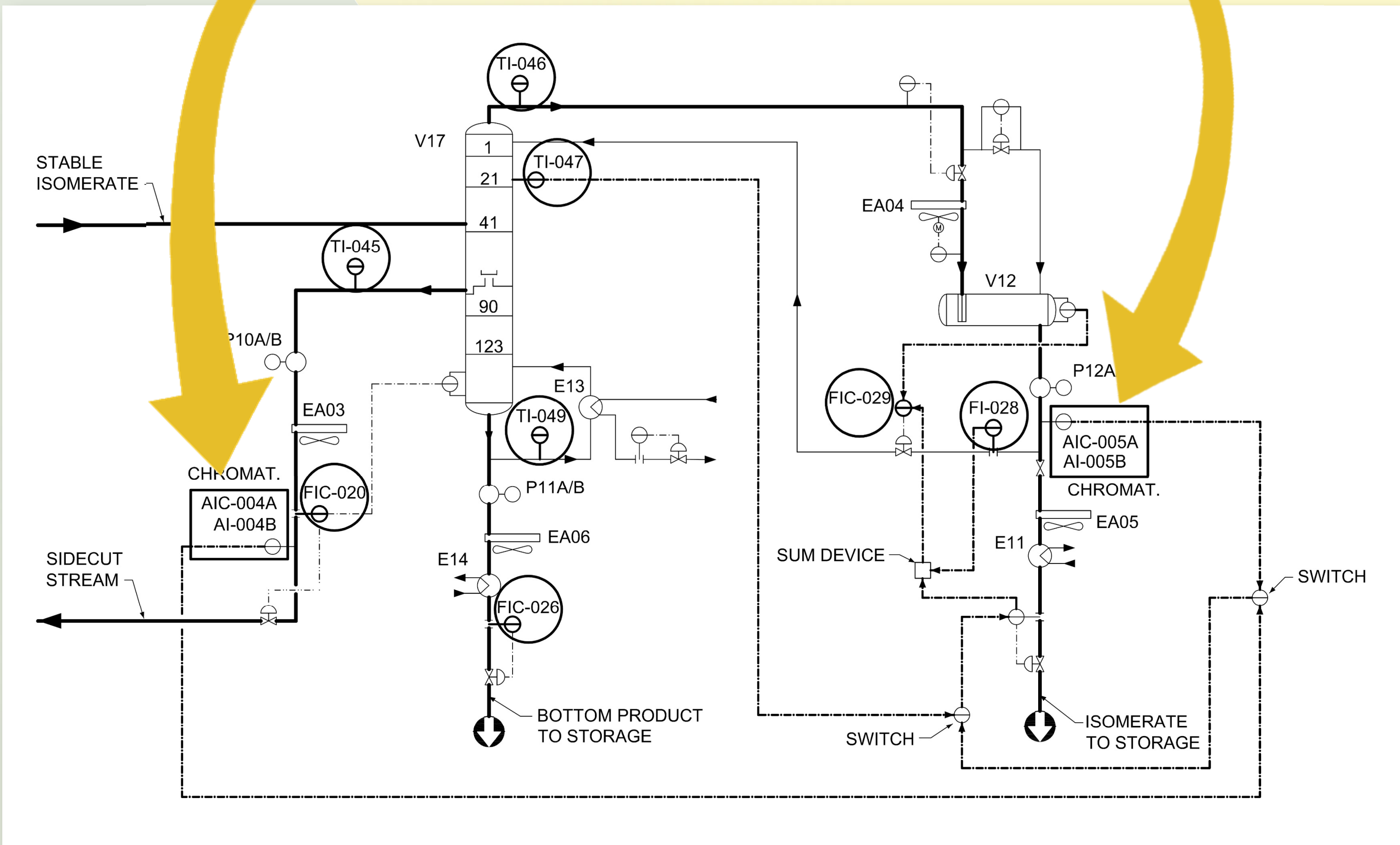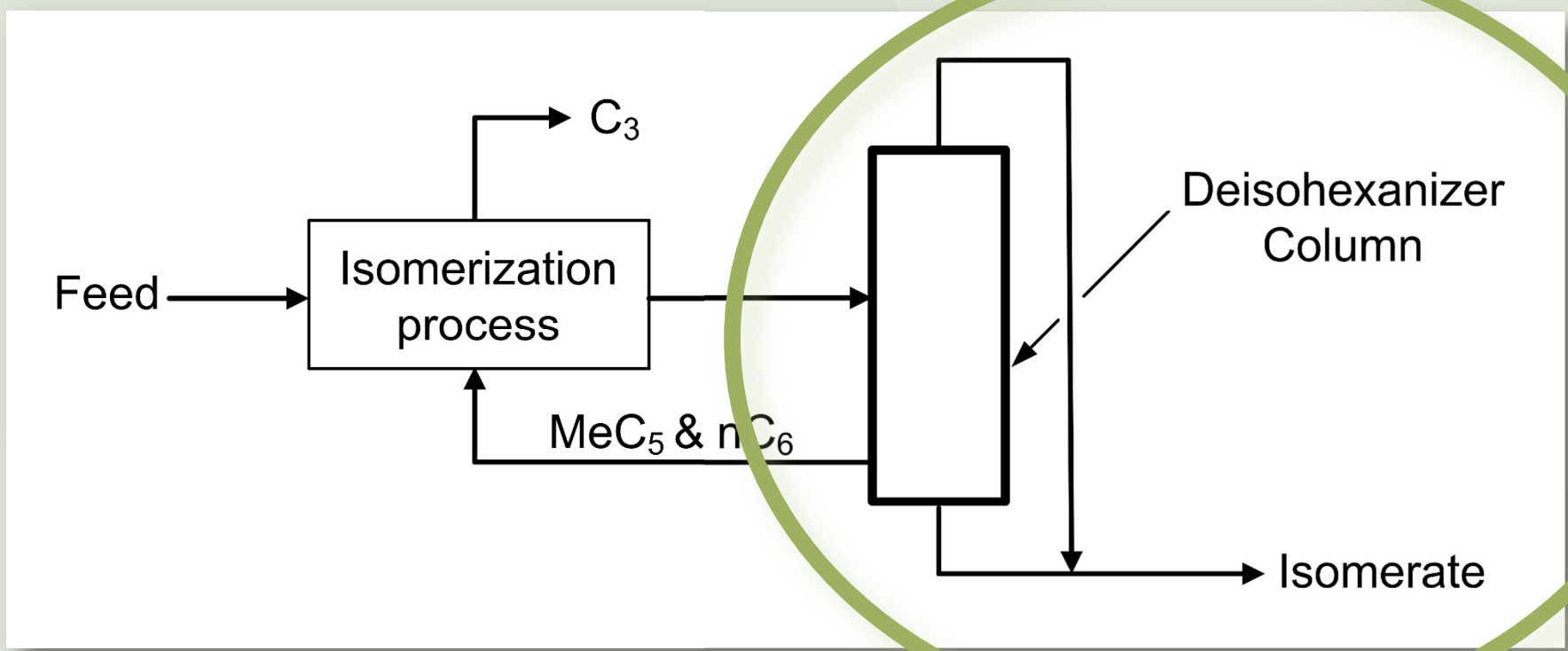
PROCESS & MODELS

Inlet space   Feature space

y

$f(\mathbf{x})+\varepsilon$
$f(\mathbf{x})$
$f(\mathbf{x})-\varepsilon$

ξ
ξ^*

● fitted by SVM
○ data point
◉ support vector

x

TI-30046
TIC-30047
TI-30045
TI-30049
FI-30028
FIC-30029
FIC-30020
FIC-30026

SVM MODEL

2,3-DMB Content

2-MP Content

C_3

Feed → Isomerization process → Deisohexanizer Column → Isomerate

MeC$_5$ & nC$_6$

STABLE ISOMERATE

V17
1
21
41
90
123

TI-046
TI-047
TI-045
TI-049

P10A/B
EA03
FIC-020
AIC-004A
AI-004B
CHROMAT.

SIDECUT STREAM

P11A/B
E13
E14
EA06
FIC-026

BOTTOM PRODUCT TO STORAGE

EA04
V12
FIC-029
FI-028
P12A
AIC-005A
AI-005B
CHROMAT.
SUM DEVICE
E11
EA05

SWITCH
SWITCH

ISOMERATE TO STORAGE

EVOLUTION CRITERIA & RESULTS

FIT	FPE	RMSE	AE
$1-\dfrac{\sqrt{\sum_{i=1}^{n}(\hat{y}_i - y_i)^2}}{\sqrt{\sum_{i=1}^{n}(y_i - \bar{y})^2}}\cdot 100$	$V\left(1 + 2d/n\right)$	$\sqrt{\dfrac{\sum_{i=1}^{n}(\hat{y}_i - y_i)^2}{n}}$	$\dfrac{1}{n}\sum_{i=1}^{n}\left|\hat{y}_i - y_i\right|$

2,3-DMB model evaluation

FIT	FPE	RMSE	AE
84.67 %	0.014	0.118 % mole	0.077 % mole

2-MP model evaluation

FIT	FPE	RMSE	AE
82.98 %	0.249	0.499 % mole	0.317 % mole

— SVM model
-- measured

2,3-DMB Content [% mole] vs Sample

— SVM model
-- measured

2-MP Content [% mole] vs Sample