A SEGMENTED CAPACITANCE TOMOGRAPHY FOR VISUALISING MATERIAL DISTRIBUTIONS IN PIPELINE CONVEYING CRUDE PALM OIL

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ABSTRACT

A segmented electrical capacitance tomography ECT imager or palm oil process monitoring system is constructed and presented in this ork.The goal o this study is to use the process monitoring system as an instrument to upkeep the local and oreign palm oil mill. This is to ensure that the monitoring o crude palm oil CPO in conveying pipeline during extraction o palm oil mill process lo process is e iciently controlled. The system has the capa ility to visualize the percentage o li uid that exist ithin the vessel there ore the data can e utilized to design and create etter process e uipment in mill process. It ill also e used to control some processes in order to oost the uality o crude palm oil and the POME Palm Oil Mill E luent treatment process. Most ECT in earlier research ere created rapidly and utilized ell in multiphase lo measurement in numerous applications such as in oil and gas industries, gas/solids cyclone, milk lo s and luidized eds. Experimentally, this ork investigates the capa ility o using a t in-plane segmented ECT sensor ith 16 porta le electrodes using t o di erential excitation potentials transmitted signal in order to recognize the concentration and velocity pro ile as ell as the phase concentration o crude palm oil related multiphase systems li uid and gas . The attained concentration pro ile hich is received rom the capacitance measurements is capa le to provide image o the li uid and gas mixture in the pipeline there ore, the separation process et een oil and li uid aste ecomes much easier and the crude palm oil's quality can be dependably monitored. The visualization results deliver in ormation regarding the lo regime, super icial velocity and concentration distri ution in t o-phase lo -rate measurement system incorporating a li uid lo measuring device. The in ormation o tained is a le to help in the process e uipment designing, veri ication o existing computational modeling and simulation techni ues. It may also assist in process control and monitoring during the palm oil extraction process.

ABSTRAK

Pengime kapasitan elektrik ersegmen tomogra i ECT agi sistem paparan proses kelapa sa it telah di ina dan dipersem ahkan dalam ker a ini. Matlamat sistem ini adalah untuk digunakan se agai instrumen untuk mengekalkan kualiti minyak sa it tempatan dan asing. Ini adalah untuk memastikan aha a pemantauan penghantaran aliran proses minyak sa it mentah menerusi saliran ketika proses pengekstrakan minyak sa it dapat dika al dengan le ih e ekti . Sistem paparan ini mempunyai keupayaan untuk memaparkan peratusan cecair yang u ud dalam saliran, dengan itu data terse ut oleh digunakan untuk mereka entuk dan mencipta peralatan untuk proses yang le ih aik agi kilang pemprosesan. Ia uga oleh digunakan untuk menga al e erapa proses untuk meningkatkan kualiti minyak sa it mentah dan proses ra atan POME Palm Oil Mill Sdn E luen . Ke anyakan ECT dalam penyelidikan a al telah dicipta dengan pantas dan digunakan dengan aik agi pengukuran aliran er ilang asa dalam pel agai aplikasi seperti industri minyak dan gas, gas / pepe al siklon, aliran susu dan pepe al ter endalir. Ka ian penyelidikan ini akan menganalisa keupayaan pengesan ECT satah- erkem ar dengan 16 elektrod mudah alih dengan menggunakan dua isyarat pengu aan eza upaya yang erlainan untuk mengenalpasti konsentrasi dan pro il hala u serta konsentrasi asa minyak sa it mentah er ilang asa dengan yang ersekutu dengannya cecair dan gas . Pro il konsentrasi yang dikenal pasti daripada pengukuran menerusi sistem terse ut mampu untuk memaparkan campuran gas dalam saluran paip. Oleh itu proses pengasingan minyak erasingan dan sisa cecair men adi le ih mudah dan kualiti minyak sa it mentah oleh dipantau. Keputusan visualisasi memaparkan maklumat mengenai aliran, hala u permukaan dan ta uran konsentrasi menerusi sistem pengukuran kadar aliran dua asa yang diga ungkan dengan peranti pengukur aliran cecair. Maklumat ini dapat mem antu dalam proses mereka entuk peralatan, pengesahan pemodelan pengiraan sedia ada dan teknik simulasi. Ia uga dapat mem antu dalam ka alan proses serta pemantauan sepan ang proses perahan minyak sa it.

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LIST OF ABBREVIATIONS

°	-	degree
AC	-	Alternative-Current
ADC	-	analog to digital converter
ANOVA	-	Analysis o variance
CMOS	-	complementary metal oxide semiconductor
CpK	-	Process capa ility
DAC	-	digital to analog converter
DAS	-	Data ac uisition system
ECT	-	Electrical Capacitance Tomography
EEPROM	-	Electrical Erasa le Programma le Read Only Memory
EIT	-	Electrical Impedance Tomography
ESD	-	electrostatic discharge
ps	-	rame per second
GUI	-	Graphical user inter ace
GR R	-	Gauge o repeata ility and reproduci ility
Hz	-	Hertz
I/O	-	Input / Output
IDC	-	insulation displacement contact
IOCTL	-	input and output control
IPT	-	Industrial Process Tomography
ISA	-	Industry Standard Architecture
kΩ	-	kilo-ohm
k ps	-	kilo it per second
kHz	-	kilohertz
LBP	-	Linear Back Pro ection

LED	-	light emitting diode
MATLAB	-	Matrix La oratory
Max.	-	Maximum
M ps	-	Mega it per second
MHz	-	MegaHertz
mm	-	millimetres
MOR	-	Model Based Reconstruction
MRI	-	magnetic resonance imaging
ms	-	millisecond
MSIRT	-	Multiplicative simultaneous iterative reconstruction techni ue
NMR	-	Nuclear Magnetic Resonance
NMRT	-	Nuclear Magnetic Resonance Tomography
OIOR	-	O line iteration and online reconstruction
op-amp	-	operational ampli ier
PC	-	Personal Computer
PCB	-	Printed Circuit Board
PET	-	Positron Emission Tomography
PSNR	-	peak signal-to-noise ratio
PT	-	Process Tomography
PTL	-	Process Tomography Limited
RAM	-	Random Access Memory
RMSE	-	root mean s uare error
SNR	-	Signal to Noise Ratio
SPI	-	Serial Peripheral Inter ace
SW	-	S itch
USB	-	Universal Serial Bus
V_{p-p}	-	Voltage peak-to-peak

LIST OF SYMBOLS

A	-	Total gain o measurement system
A/D	-	Analog to digital
C	-	Matrix o inter-electrode capacitance
C_H	-	Capacitance measured at higher permittivity
C_L	-	Capacitance measured at lo er permittivity
C_M	-	Measured capacitance
C_N	-	Normalized capacitance
C_{oil}	-	Relative capacitance o oil
C_r	-	Relative capacitance
C_{s1}	-	Stray capacitance o connecting lead
C_{s2}	-	Stray capacitance at Op-Amp eed ack point
C_{ater}	-	Relative capacitance o ater
C_x	-	unkno n standing capacitance
d	-	Distance o 2 parallel plate
D	-	Sensor diameter
ε	-	E ective permittivity
ε_0	-	Permittivity o ree space
ε_o	-	Relative permittivity o oil
ε_r	-	Relative permittivity
ε	-	Relative permittivity o ater
f	-	Fre uency
$f_{unitygain}$	-	Unity gain re uency
K	-	Matrix o permittivity
K_e	-	E ective pixel permittivity
K_{en}	-	Normalized e ective pixel permittivity

K_H	-	Pixel permittivity at lo er permittivity
K_L	-	Pixel permittivity at higher permittivity
L	-	Length o electrode
m	-	Num er o individual standing capacitance
M	-	Total num er o pixels
n	-	Total num er o pixels
N	-	Num er o measuring electrodes
Q	-	Unkno n matrix
S	-	Sensitivity matrix
$\mathbf{S}^{-1}$	-	Inverse sensitivity matrix
SNR	-	Signal to Noise Ratio
$\mathbf{S}^{T}$	-	Transpose sensitivity matrix
V_i	-	Input voltage
V_o	-	Output voltage
VR	-	Volume ratio
W	-	Width o electrode
x	-	Volume ratio
$\Delta\mathbf{C}$	-	Error capacitance matrix
$\Delta\mathbf{K}$	-	Error pixel matrix
ω_o	-	Corner re uency

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