

Supporting Information

Modeling Identification and Control of an Air Preheating Furnace of a Pneumatic Conveying and Drying Process

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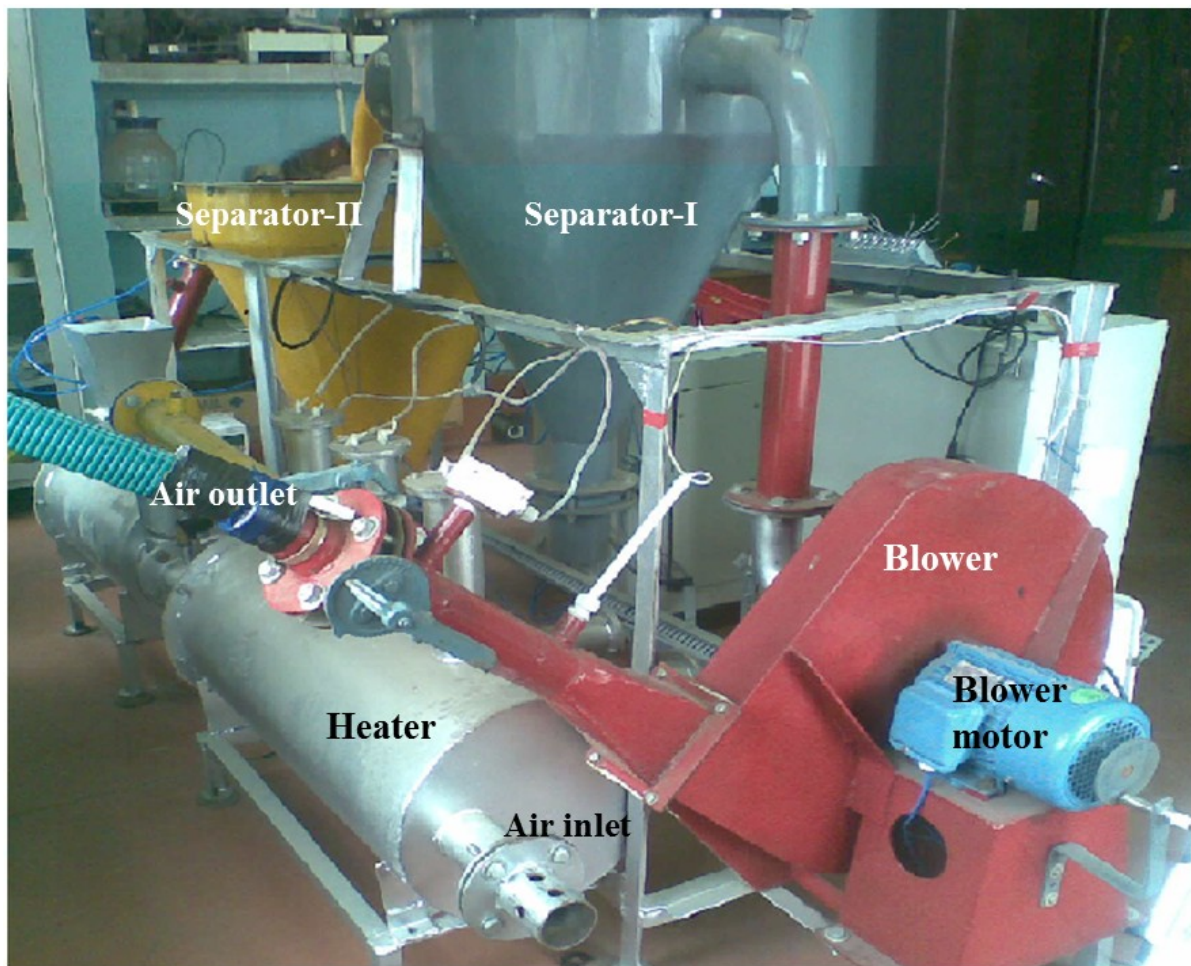


Figure S1. Photograph of the experimental setup.

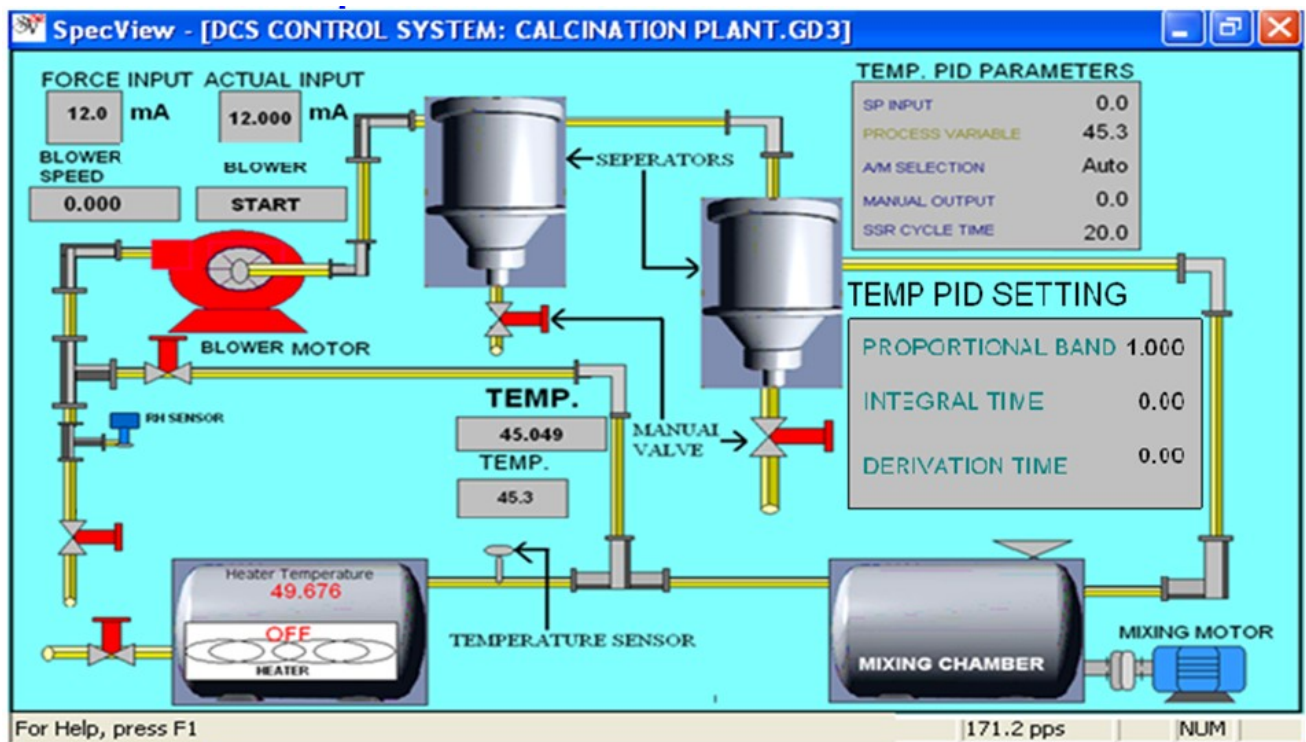
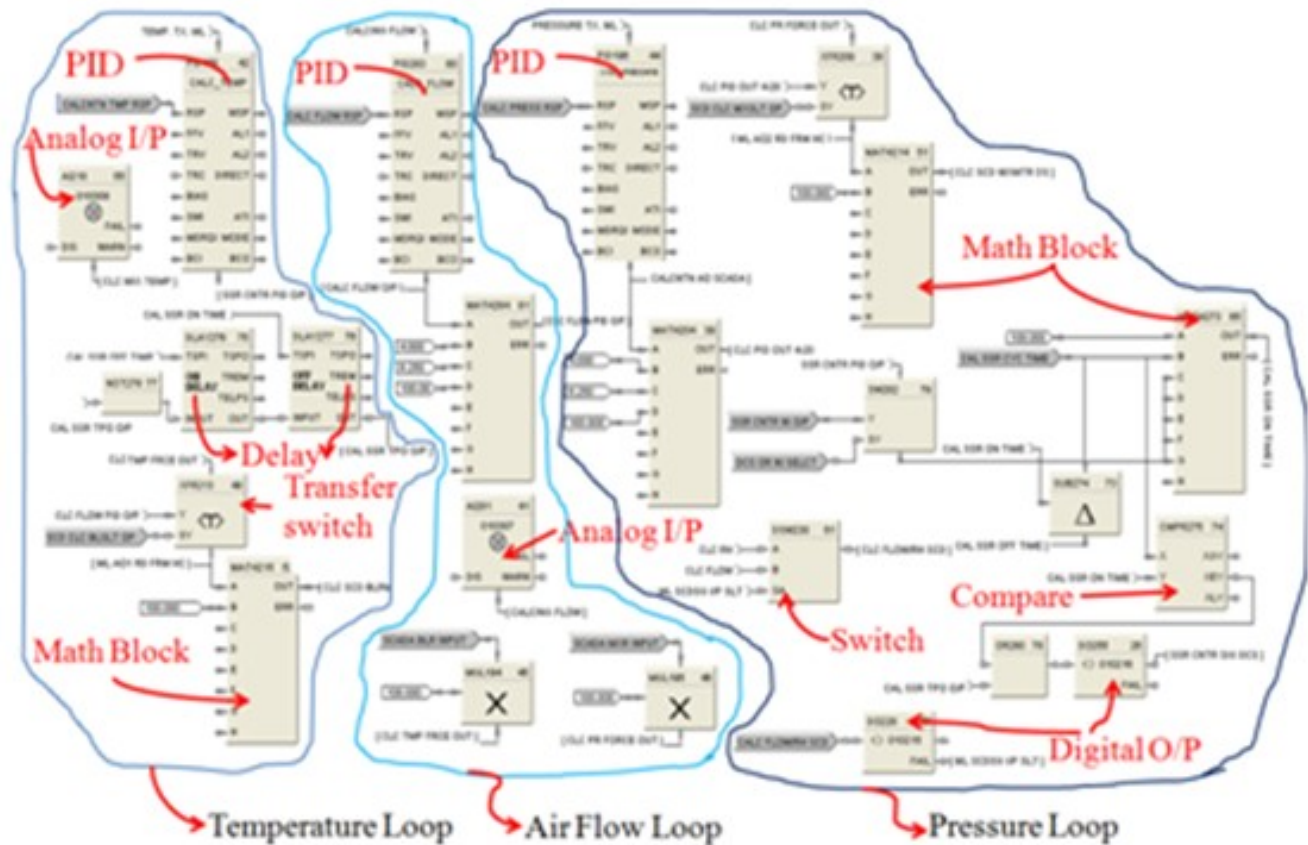


Figure S2. SCADA implementation of the pneumatic conveying system.

Table S1. Performance Measures.

Model	Operating Region	<i>rms error</i>	<i>Cross-correlation</i>
Model-I	Low	0.106	0.937
	Medium	0.164	0.929
	High	0.094	0.953
Model-II	Low	0.063	0.973
	Medium	0.072	0.968
	High	0.046	0.982
Model-III	Low	0.069	0.973
	Medium	0.083	0.957
	High	0.061	0.978
Worst case uncertain plant	Entire	3.492	0.672
Best case uncertain plant	Entire	0.094	0.956

Table S2. Search Range of Controller Parameters

Parameter of the controller to be search	Lower Bound	Upper Bound
a_0	1e-2	1e4
a_1	1e-1	1e3
b_0	1e-1	1e3
b_1	1e-1	1e3

Table S3. Graphically Obtained Values of QFT Bounds

Design Frequencies	Phase (degree)	Magnitude (dB)	$L(j\omega)$
0.001	-89.82	53.36	-1.3073e+02 - 4.4686e+02i
0.01	-91.03	37.12	-71.5712 - 5.4634i
0.05	-101.39	21.67	7.9164 - 9.1774i
0.07	-109.56	13.38	-4.3059 - 1.7989i
0.15	-113.71	11.49	3.0713 - 2.1588i
0.3	-126.37	1.23	0.8765 - 0.7478i
0.5	-131.64	-2.61	0.7059 +0.2237i
1	-138.81	-12.6	0.1961 - 0.1285i
15	-140.24	-14.83	-0.0771 - 0.1641i

Table S4. PSO and Objective Function parameters

Parameters	values
Maximum Iteration	1000
Population Size	50
Dimension	4
Value of K2	2
Maximum Weight	0.90
Minimum Weight	0.40
N	9
I_1	100
I_2	10
q	20
$\mu_1(0)$	1e8
$\mu_{2i}(0)$	1e4
$\mu_{3i}(0)$	1e2