u(*t*-3)	1.2000	1.2000	1.2000	1.1940	1.1470
u(*t*-4)	0.1000	0.1000	0.1000	--	--
Number of repeated solution		13	16	10	11
*OFn*1		1.66×10^{-31}	8.66×10^{-32}	3.88×10^{-04}	4.01×10^{-02}
*OFn*2		5	4	3	2

Table 4. Details of models for S2 system

Terms	Actual	E	F	G	H
Constant	--	--	--	--	--
y(*t*-1)	0.7970	0.7970	0.7970	0.7999	0.8047
y(*t*-2)	--	--	--	--	--
y(*t*-3)	-0.2370	-0.2370	-0.2370	-0.2380	-0.2429
y(*t*-4)	--	--	--	--	--
y(*t*-5)	--	--	--	--	--
u(*t*-1)	0.4410	0.4410	0.4410	0.4429	0.4422
u(*t*-3)*u*(*t*-5)	0.3330	0.3330	0.3330	0.3289	--
Number of repeated solution		1	9	5	6
*OFn*1		2.82×10^{-32}	1.06×10^{-31}	3.61×10^{-05}	8.01×10^{-04}
*OFn*2		6	5	4	3

4.2 Modeling POB system

A NARX model is used as model representation for the system. The model parameters used are five input-output lags (nu = ny = 5) and two degree of nonlinearity (l = 2), with the genetic parameters of MOODE used is given in Table 2. The tradeoff between two objective functions i.e. model predictive error (OFn1) and model complexity (OFn2) from the final generation is illustrated. This illustration called Pareto-optimal front to show the number of models that represent the POB system.

Fig. 6 shows the non-dominated models obtained from the final generation using the MOODE algorithm. The non-dominated models consist of 21 models of representing the dynamic behavior of POB system. Four out of those models are randomly selected and marked as D1, D2, D3, and D4. All selected models are chosen based on their complexity whereas the model predictive error of each model is not much different. The highest model complexity is 31 terms while the lowest model complexity is 2 terms only as shown in Fig. 6 which gives big difference between these two. However, the model complexity is given priority in choosing the compact model but adequately capture dynamic of the system [8]. The detail of the selected models is listed in Table 5.

Each selected model shows the nonlinear model which consists of single term and cross term as can be seen in Table 5. The model predictive errors of optimal models are all within the range of 1.10 – 1.20×10-03. However, the model complexity of marked models are diverse where the lowest model complexity is 2 terms for model D4 while the highest model complexity is 10 terms for model D1. Observing to the number of repeated solution, model D3 indicates the higher value of repeated solutions with 5 repetitions. Meanwhile, the second higher value of repeated solution comes from models D1 and D4. From the previous study on the simulated systems, the model with the highest number of repeated solution should be given priority to be chosen. Therefore, model D3 is a possible model to be chosen to represent the dynamic behavior of POB system. However, all models have to be validated using the model validity tests, before selecting a good and adequate model.

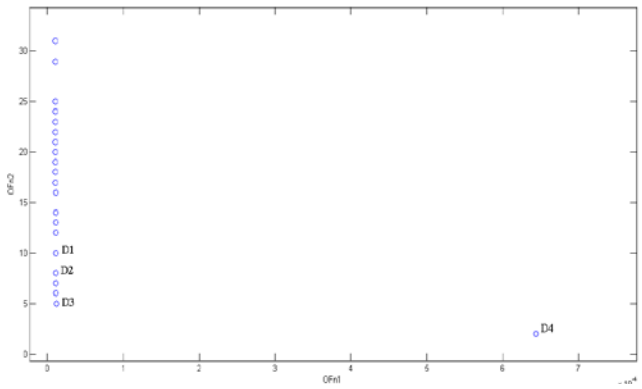

Fig. 6. The non-dominated models obtained for POB system

Table 5. Details of selected models for POB system