Ilkogretim Online - Elementary Education Online, 2020; Vol 19 (Issue 4): pp. 6780-6787
http://ilkogretim-online.org
doi: 10.17051/ilkonline.2020.04.765082

Modeling & Analysis Of Boiler Drum Control System Using Petri Nets

R.Chithrakkannan[1] , sri sairam Engineering college ;

T.Mangayarkarsi[2], sri sairam Engineering;

R.Karthikeyan[3], sri sairam Engineering

Abstract—The aim behind this paper is to develop the The boiler drum system considered in this paperuses Petri Net unique model for analyzing the fail safe condition and performance of the boiler drum section using Petri Nets. The structural and behavioural properties of the developed Petri net models serves as a tool for model checking and redundancy checking which are essentialto verify the correctness of boiler drum dynamics. This is followed by the validation and performance evaluation of the developed model .The developed model helps in providing safety analysis during operation .The mathematical and graphical results obtained from the developed system helps inunderstanding and analyzing the characteristics of entire boiler drum section

Index Terms— Stochastic Petri Nets, Fail Safe Model, ModelAnalysis

Introduction

Due to the advancement of Technology in Science and need for automation there has always been a thrust to improve the capability of boiler drum section in power plants. Petri Nets combine a well-defined mathematical theory with a graphical representation of the dynamic behavior of the systems. Modeling & Analysis of the furnace is very much essential for improving the safety of risk in critical processes. Different approaches have been developed in analyzing the drum model for the past few years, depending on the kind of knowledge used to describe the dynamic process. Modeling is the most important step, since the model based approaches mainly consists of comparison between the actual behavior of the system with the reference behaviors describing the normal operation(fail safe model) and modeling using Petri nets. Once the model is built, redundancy of the model can be checked by using Petri Nets.The model can be developed by considering the complete logical based approach in developing the furnace model using Petri Nets.

In this regard, the concept of the fail safe model plays a major role in indicating and informing about something which is going wrong in the monitored system of any process. Hence, for personal and system safety, detection and isolation have become a prime concern in many Industries. Many different approaches have been dealt in achieving the fail safe and modeling of the boiler drum control system.

soft wares like HpSim for developing a fail -safe and SIRPHYCO for developing a model for performance evaluation. The HpSim and SIRPHYCO soft wares uses places, transitions and tokens for developing the fail-safe model and a model for the performance evaluation respectively.

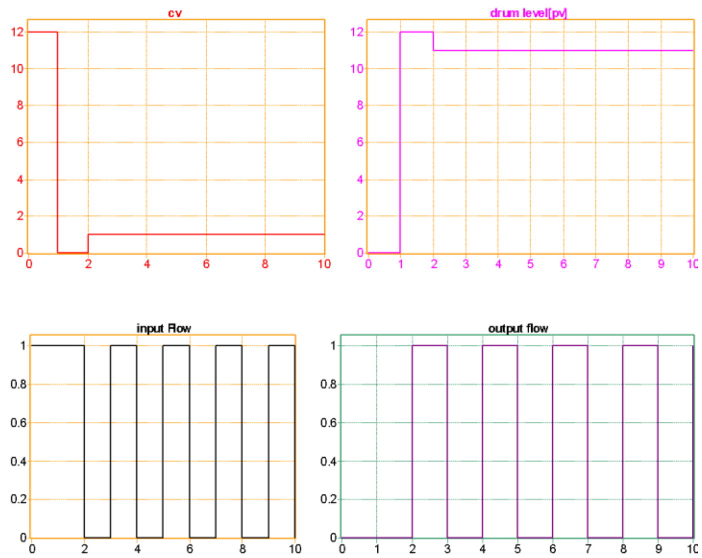
2. SYSTEM DESCRIPTION

The design of the boiler drum model is based on the concept of the discrete and continuous Petri Nets. A Petri net(PN) has two types of nodes, namely places and transitions. A place is represented by a circle and a transition by a bar. Places and transitions are connected byarcs. The number of places is finite and not zero. The number of transitions is also finite and not zero. An arc is directed and connects either a place to a transition or a transition to a place.

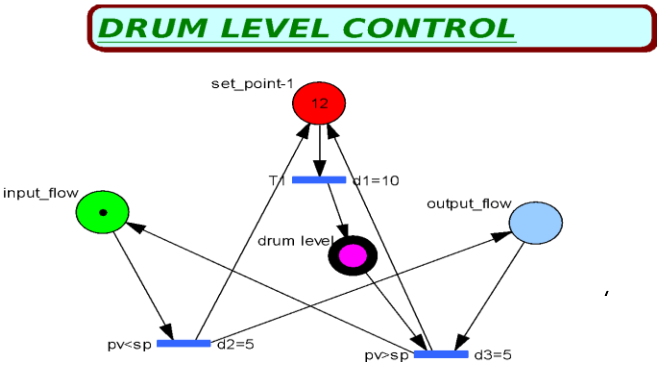
In other words, a PN is a bipartite graph, i.e, places and transitions alternate on a path made up of consecutive arcs. It is compulsory for each arc to have a node at each of its ends. A transition without an input place is a source transition. A transition without an output place is a sink transition.

3. SYSTEM MODELING

As mentioned in the earlier section, the system modeling is done by using Petri Nets, considering the whole process as a continuous event system. The presence of a token in a place denotes the condition for starting an operation or event, firing a transition denotes the start of the event and movement of the token from one place to another represents condition after the operation or event is



completed.



DESCRIPTION OF THE MODEL

The description of the boiler drum model is performed easily with the help of the Petri nets. The set pointor the desired value is being given by the tokens in the place P1.The tokens from the place P1 is being passed to the drum level control denoted by place P2 where the drum level is checked with the desired value. If the drum level value is less than the set point then the input flow valve(P3) is ON and the output flow valve(P4) is OFF. If the drum level is greater than the set point value then the input flow valve (P3)is OFF and the output flow valve(P4) is ON.

TABLE-I

DESCRIPTION OF PLACES /TRANSITIONS AND CONDITIONS FORTHE MODEL

S.No	PLACES/ TRANSITIONS	CONDITIONS
1.	P1	Initialize the set point value
2.	T1	To enable tokens to be passed from place P1 to P2(set point to the drum level control)
3.	T2	To check if the drum level is <set point
4.	P2	To open the input valve for increasing the input flow.
5.	P3	To open the output valve for bringing to the desired value.
6.	T3	To check if the drum level is > set point.

4-GRAPHICAL RESPONSE

From the above graphical output, we can conclude that

i) If the value of the drum level is < set point, then the drum level controller takes action and the input valve isopened and the output valve is closed.

ii) If the value of the drum level is >set point, then the drum level controller takes action and the input valve is closed andthe output valve is opened.

5. FAIL SAFE MODEL OF THE DRUM SECTION OFTHE BOILER

This section describes the methods of developing the fail safe model of the boiler drum section and the conditions for the fail safe operation of the boiler.

5.1 Fail Safe Model

The boiler drum is very much needed for the proper working of the boiler and to make it operate smoothly and efficiently. Thus, a fail safe model is very much essential for the proper design of the boiler drum by choosing of the appropriate variables required for the boiler drum and ensuring the normal operation of the boiler.

5.2 Fail Safe Monitoring Algorithm

With regard to the drum section of the boiler and modeling of the boiler drum section in its equivalent Petri Net environment, the following criterion is adopted.

STEP1: Set the tokens in the place P1 considering it as the normal place.

STEP2: Now the controller checks if the level of the drum

STEP 3: If the level of the drum is < 5 then the furnace is passed to the OFF position and the feed water is passed to the ON position.

STEP4: If the level of the drum is> 25 then the feed water valve is passed to the OFF position and the furnace to theon position.

Fig:

6- PN TOOL:

The Petri Net Toolbox (PN Toolbox) version 2.0 is a software tool for simulation, analysis and design of discrete event systems, based on Petri net (PN) models. This software is embedded in the MATLAB environment and its usage requires version 6.0 or higher. The orientation of the PN Toolbox was meant to permit further development in the sense of hybrid systems, because MATLAB incorporates comprehensive libraries for studying continuous and discontinuous dynamics. Such a development, of extreme importance for control engineering, would be hardly approachable relying on the already existing PNs packages as requiring sophisticated interfaces for the cooperation with instruments devoted to the exploration of continuous dynamics with the models developed in the recent years mainly with reference to the boiler models.

INCIDENCE MATRIX:

The incidence matrix suffices to characterize the relative change of tokens for every place when a transition fires.

COVERABILITY GRAPGH:

The coverability tree is a tree representation of all possible markings .If the net is unbounded then the tree is kept finite by introducing the symbol ω.

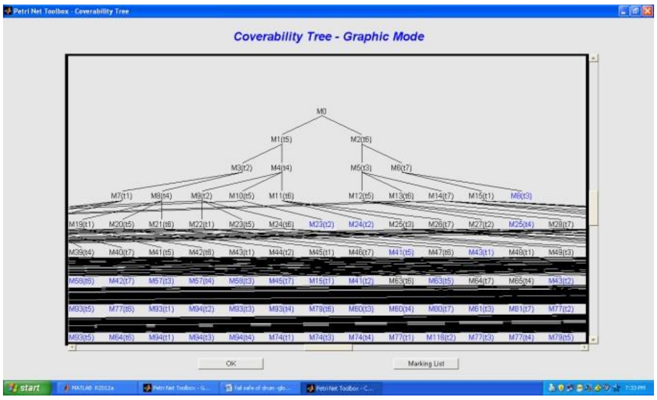
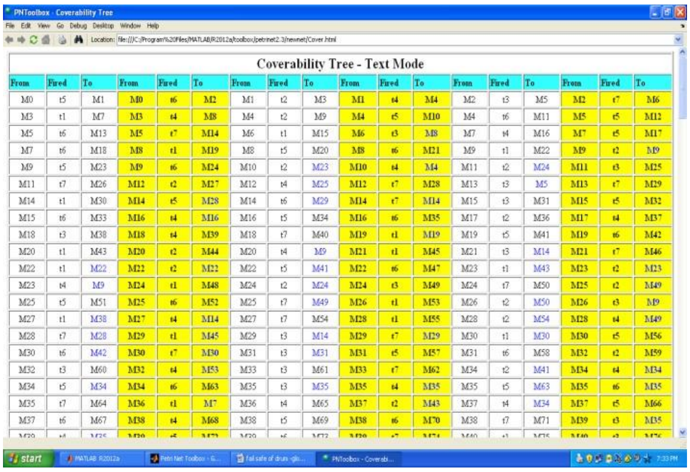


Fig. 2. Example of an unacceptable low-resolution image

COVERABILITY TREE TEXT MODE:

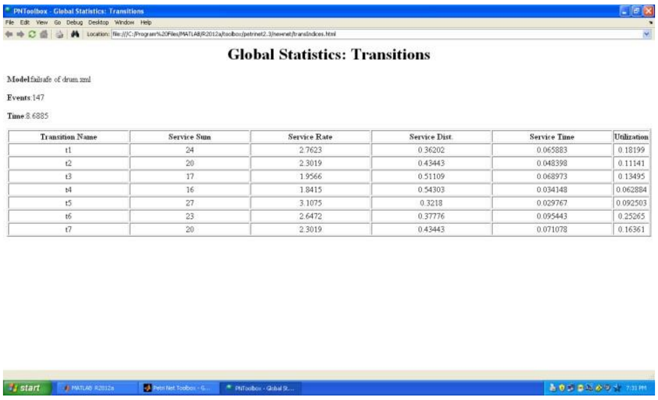

Coverability Tree - Text Mode

From	Fired	To	From	Fired	To	From	Fired	To	From	Fired	To	From	Fired	To	From	Fired	To
M0	t5	M1	M0	t6	M2	M1	t2	M3	M1	t4	M4	M2	t3	M5	M2	t7	M6
M3	t1	M7	M3	t4	M8	M4	t2	M9	M4	t5	M10	M4	t6	M11	M5	t5	M12
M5	t6	M13	M5	t7	M14	M6	t1	M15	M6	t3	M8	M7	t4	M16	M7	t5	M17
M7	t6	M18	M8	t1	M19	M8	t5	M20	M8	t6	M21	M9	t1	M22	M9	t2	M9
M9	t5	M23	M9	t6	M24	M10	t2	M23	M10	t4	M4	M11	t2	M24	M11	t3	M25
M11	t7	M26	M12	t2	M27	M12	t4	M25	M12	t7	M28	M13	t3	M5	M13	t7	M29
M14	t1	M30	M14	t5	M28	M14	t6	M29	M14	t7	M14	M15	t3	M31	M15	t5	M32
M15	t6	M33	M16	t4	M16	M16	t5	M34	M16	t6	M35	M17	t2	M36	M17	t4	M37
M18	t3	M38	M18	t4	M39	M18	t7	M40	M19	t1	M19	M19	t5	M41	M19	t6	M42
M20	t1	M43	M20	t2	M44	M20	t4	M9	M21	t1	M45	M21	t3	M14	M21	t7	M46
M22	t1	M22	M22	t2	M22	M22	t5	M41	M22	t6	M47	M23	t1	M43	M23	t2	M23
M23	t4	M9	M24	t1	M48	M24	t2	M24	M24	t3	M49	M24	t7	M50	M25	t2	M49
M25	t5	M51	M25	t6	M52	M25	t7	M49	M26	t1	M53	M26	t2	M50	M26	t3	M9
M27	t1	M38	M27	t4	M14	M27	t7	M54	M28	t1	M55	M28	t2	M54	M28	t4	M49
M28	t7	M28	M29	t1	M45	M29	t3	M14	M29	t7	M29	M30	t1	M30	M30	t5	M56
M30	t6	M42	M30	t7	M30	M31	t3	M31	M31	t5	M57	M31	t6	M58	M32	t2	M59
M32	t3	M60	M32	t4	M53	M33	t3	M61	M33	t7	M62	M34	t2	M41	M34	t4	M34
M34	t5	M34	M34	t6	M63	M35	t3	M35	M35	t4	M35	M35	t5	M63	M35	t6	M35
M35	t7	M64	M36	t1	M7	M36	t4	M65	M37	t2	M43	M37	t4	M34	M37	t5	M66
M37	t6	M67	M38	t4	M68	M38	t5	M69	M38	t6	M70	M38	t7	M71	M39	t3	M35

fig

GLOBAL STATISTCS OF TRANSITIONS

The global statistics of the transitions involves up in the entirer global data of all the transitions that have been involved in firing.



PNToolbox - Global Statistics: Transitions

File Edit View Go Debug Desktop Window Help

Location: file:///C:/Program%20Files/MATLAB/R2012a/toolbox/petrinet2.3/newnet/transIndices.html

Global Statistics: Transitions

Model:failsafe of drum.xml

Events:147

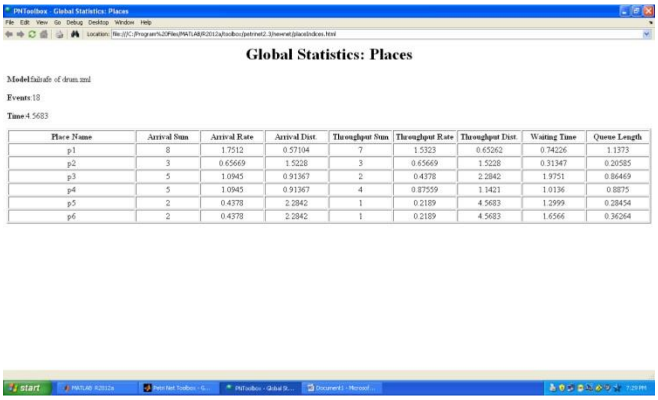
Time:8.6885

Transition Name	Service Sum	Service Rate	Service Dist.	Service Time	Utilization
t1	24	2.7623	0.36202	0.065883	0.18199
t2	20	2.3019	0.43443	0.048398	0.11141
t3	17	1.9566	0.51109	0.068973	0.13495
t4	16	1.8415	0.54303	0.034148	0.062884
t5	27	3.1075	0.3218	0.029767	0.092503
t6	23	2.6472	0.37776	0.095443	0.25265
t7	20	2.3019	0.43443	0.071078	0.16361

CONCLUSION

GLOBAL STATISTCS OF PLACES

The global statistics of the places involves up in the entire global data of all the places that have been involved inpassing of tokens to other places.



PNToolbox - Global Statistics: Places

File Edit View Go Debug Desktop Window Help

Location: file:///C:/Program%20Files/MATLAB/R2012a/toolbox/petrinet2.3/newnet/placeIndices.html

Global Statistics: Places

Model:failsafe of drum.xml

Events:18

Time:4.5683

Place Name	Arrival Sum	Arrival Rate	Arrival Dist.	Throughput Sum	Throughput Rate	Throughput Dist.	Waiting Time	Queue Length
p1	8	1.7512	0.57104	7	1.5323	0.65262	0.74226	1.1373
p2	3	0.65669	1.5228	3	0.65669	1.5228	0.31347	0.20585
p3	5	1.0945	0.91367	2	0.4378	2.2842	1.9751	0.86469
p4	5	1.0945	0.91367	4	0.87559	1.1421	1.0136	0.8875
p5	2	0.4378	2.2842	1	0.2189	4.5683	1.2999	0.28454
p6	2	0.4378	2.2842	1	0.2189	4.5683	1.6566	0.36264

The version of this template is V3. Most of the formatting instructions in this document have been compiled by Causal Productions from the IEEE LaTeX style files. Causal Productions offers both A4 templates and US Letter templates for LaTeX and Microsoft Word. The LaTeX templates depend on the official IEEEtran.cls and IEEEtran.bst files, whereas the Microsoft Word templates are self-contained. Causal Productions has used its best efforts to ensure that the templates have the same appearance.

Causal Productions permits the distribution and revision of these templates on the condition that Causal Productions is credited in the revised template as follows: “original version of this template was provided by courtesy of Causal Productions (www.causalproductions.com)”.

ACKNOWLEDGMENT

The heading of the Acknowledgment section and the References section must not be numbered.

Causal Productions wishes to acknowledge Michael Shell and other contributors for developing and maintaining the IEEE LaTeX style files which have been used in the preparation of this template. To see the list of contributors, please refer to the top of file IEEETran.cls in the IEEELaTeX distribution.

MARKINGS:

M[p1,p2,p3,p4,p5,p6]

M0 = [1,0,0,0,0,0] M1 = [0,0,0,0,1,1]
M2 = [0,0,1,1,0,0] M3 = [0,1,0,0,0,1]
M4 = [1,0,0,0,ω,0] M5 = [1,0,ω,0,0,0]
M6 = [0,1,0,1,0,0] M7 = [1,0,0,0,0,ω]
M8 = [1,ω,0,0,0,0] M9 = [1,ω,0,0,ω,0]
M10 = [0,0,0,0,ω,1] M11 = [0,0,1,1,ω,0]
M12 = [0,0,ω,0,1,1] M13 = [0,0,ω,1,0,0]
M14 = [1,ω,ω,0,0,0] M15 = [1,0,0,ω,0,0]
M16 = [ω,0,0,0,0,ω] M17 = [0,0,0,0,1,ω]
M18 = [0,0,1,1,0,ω] M19 = [ω,ω,0,0,0,0]M20 = [0,ω,0,0,1,1]

REFERENCES

[1] S. M. Metev and V. P. Veiko, Laser Assisted Microtechnology, 2nd ed., R. M. Osgood, Jr., Ed. Berlin, Germany: Springer-Verlag, 1998.
[2] J. Breckling, Ed., The Analysis of Directional Time Series: Applications to Wind Speed and Direction, ser. Lecture Notes in Statistics. Berlin, Germany: Springer, 1989, vol. 61.
[3] S. Zhang, C. Zhu, J. K. O. Sin, and P. K. T. Mok, "A novel ultrathin elevated channel low-temperature poly-Si TFT," IEEE Electron Device Lett., vol. 20, pp. 569–571, Nov. 1999.
[4] M. Wegmuller, J. P. von der Weid, P. Oberson, and N. Gisin, "High resolution fiber distributed measurements with coherent OFDR," in Proc. ECOC'00, 2000, paper 11.3.4, p. 109.
[5] R. E. Sorace, V. S. Reinhardt, and S. A. Vaughn, "High-speed digital-to-RF converter," U.S. Patent 5 668 842, Sep. 16, 1997.
[6] (2007) The IEEE website. [Online]. Available: http://www.ieee.org/
[7] M. Shell. (2007) IEEEtran webpage on CTAN. [Online]. Available: http://www.ctan.org/tex-archive/macros/latex/contrib/IEEEtran/
[8] FLEXChip Signal Processor (MC68175/D), Motorola, 1996.
[9] "PDCA12-70 data sheet," Opto Speed SA, Mezzovico, Switzerland.
[10] A. Karnik, "Performance of TCP congestion control with rate feedback: TCP/ABR and rate adaptive TCP/IP," M. Eng. thesis, Indian Institute of Science, Bangalore, India, Jan. 1999.
[11] J. Padhye, V. Firoiu, and D. Towsley, "A stochastic model of TCP Reno congestion avoidance and control," Univ. of Massachusetts, Amherst, MA, CMPSCI Tech. Rep. 99-02, 1999.
[12] Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specification, IEEE Std. 802.11, 1997.