IOSR Journal of Electrical and Electronics Engineering (IOSR-JEEE)
e-ISSN: 2278-1676,p-ISSN: 2320-3331, Volume 12, Issue 4 Ver. II (Jul. – Aug. 2017), PP 55-60
www.iosrjournals.org

A Novelty Stability Of Electrical System Single Machine Based Runge Kutta Orde 4 Method

Solly Aryza[1], M. Irwanto[2], Zulkarnain Lubis[3], Andysah Putera Utama Siahaan[4]
[1]Lecture of Electrical Engineering University Pembangunan Panca budi Medan, Indonesia
[4]Lecture of Computer Science University Pembangunan Panca budi Medan, Indonesia
[1,4]Student Postgraduate University Malaysia Perlis, Kangar, Malaysia
[2]Lecture of Electrical Engineering Institute Technology Medan (ITM) Medan
[2]Lecture of University Malaysia Perlis, Kangar Malaysia
Corresponding Author: Solly Aryza

Abstract: *In electric power systems that serve the load continuously should the voltage and frequency must remain constant, but if there is interference on one of the generators or the rail, then it is undeniable there will be disruption to the power supply. It is necessary to conduct a Research on the Stability of Power Systems relating to the Determination of Critical Breaking Angle and Critical Breaker Time on the generator, to find out how much the Critical Breaker Angle and how much of a Critical Breaker Time. In this paper used Runge Kutta Method 4th order with the help of Matlab software*
Keywords*: Critical Breaker, Runge Kutta, Generator.*

Date of Submission: 22-07-2017 Date of acceptance: 05-08-2017

I. Introduction

One of the most important studies in the design and the operation of an electric power system is the transient security assessment [l], [2]. This analysis entails the evaluation of a power network ability to withstand large disturbances and to survive the transition to a normal or acceptable operating condition.

The selective tripping of one or more generating units after the occurrence of severe contingencies can be used Successfully to improve the system security [3]. This a technique that allows the tripped unit(s) to be re-synchronised to the system and brought back to full or partial load in several minutes was confined in the past to Hydro power generators. Presently, many power companies have extended its use to both fossil-fuelled and nuclear generating units [4].

In this paper, it is used the extended equal area criteria to study and analyze the tripping effect of one or more generators in the transient stability of a multimachine power System [5], [6]. This direct formulation was applied to a test network and the results were compared with the solution obtained using the Runge-Kutta method. It is also studied the influence of the trapping effect on the rotor shaft fatigue life of the remaining generators when one or more power units are trapped [7].

Based on the above background, the formulation of problems that can be presented in this research are:

1. How to use the Same Larger Criteria to determine the stability of power system at Sicanang Belawan Power Plant in a transient state.
2. How much critical Critical Clearing Angle (Critical Clearing Angle) to determine the stability of Power System in Sanyang Belawan Power Plant in a transitional state (transient).

II. Stability Of Power Systems

The power balance between load requirements and generator generation is one measure of the stability of electric power system operation. In the functioning of the power system at any time will always change the capacity and location of the load in the system. The change requires that each power plant adjusts its output power through both governor and excitation controls following system pressure changes. If this is not done, it will cause the balance of power in the system is interrupted, and the operating efficiency of the system decreases causing the system performance to deteriorate.

The electric power system consists of generating units connected to the line to serve the load. Electrical power systems that have multiple machines typically channel the load power through an interconnection line. The primary objective of the interconnection channel system is to maintain continuity and availability of important power to the increasing needs of the load. The growing power system can lead to weak system performance when disturbed. One of the severe effects is electromechanical oscillation which if not properly muffled then the system will be disrupted and can exit from the stability area to result in worse effects such as the blackout.

The stability of the lipolytic power system is a characteristic of the electrical system that allows the engine to move simultaneously in the system in normal operation and can return to a state of balance after a fault occurs. Electrical power system stability problem is related to rotor angle stability and Stability. This classification is based on the time span and mechanism of instability. The stability of the rotor angle is classified into Small Signal Stability and Transient Stability. Small Signal Stability is the stability of the system for minor disturbances in the form of non-damped electromechanical oscillations, whereas Transient Stability is due to the lack of synchronization of torque and begins with major disruptions.

The stability of the electric power system is a capability of the electrical system or its parts to maintain synchronization and balance in the system. The system stability limit is the maximum power that flows through a point in the system without causing loss of balance. Based on the disturbance nature of power system stability problems are distinguished on:

1. Steady state.
2. Transitional stability (transient).
3. Sub-stability (dynamism).

Steady state stability is the ability of a power system to maintain synchronization between the machines in the system after a minor disturbance (load fluctuations).

Transient stability is the ability of a power system to maintain synchronization after a sudden major disturbance around the first swing with the assumption that the automatic voltage regulator has not worked.

The stability of dynamism is that after the first swing (period of transient stability) the system can maintain synchronization until the system is in a new state of balance (transient stability if the AVR and governor work fast and is taken into account in the analysis).

The notion of loss of synchronization is the imbalance between the power generating and load generating a transient state which causes the rotor of the synchronous machine to swing due to the torque which results in acceleration or deceleration of the rotor. This happens when the torque is sufficiently large, then one or more of the synchronous machines will lose synchronization, for example, an imbalance caused by excessive power generation, then most of the excess energy will be converted into kinetic energy resulting in acceleration of the rotor angle increases Large, although the rotor speed increases, it does not mean that the synchronization of the machine will be lost, the determining factor is the rotor angle difference or the power is measured against the reference of the sync round.

The main factors in the problem of stability are:

1. Mechanical factors can be:

A. Prime load input torque.
B. The inertia of prime mover and generator.
C. Motor inertia and load axis.
D. Load input shaft torque.

2. Electric torque in the form:

A. The internal voltage from a synchronous generator.
B. System Reactance.

Internal voltage of the synchronous motor.

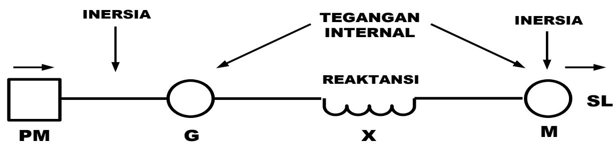

Figure1. Diagram of the main factors in the problem of stability

The generator voltage is constant with X'd direct transient axis reactance. The representation of the terminal voltage point of the generator Vg can be eliminated by transforming the impedance from relationship Y to relation Δ, so that the resulting admittance is:

$$y_{10} = \frac{Z_L}{jX'_d\, Z_S + jX'_d\, Z_L + Z_L Z_S}$$

$$y_{20} = \frac{jX_d}{jX'_d\, Z_S + jX'_d\, Z_L + Z_L Z_S} \quad (2.1)$$

$$y_{20} = \frac{Z_S}{jX'_d\, Z_S + jX'_d\, Z_L + Z_L Z_S}$$

Equivalent circuit with voltage represented by point 1 and infinite bus by point 2 can be shown in figure 2 Writing of node equation is:

$$I_1 = (y_{10} + y_{12})E - y_{12}V \qquad (2.2)$$

$$I_2 = -y_{12}E + (y_{20} + y_{21})V$$

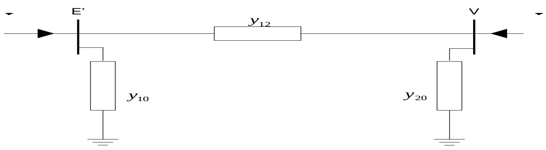

Figure2. *Equivalent circuit of one machine connected to the infinite bus*

$$P_e = R\left[E'\, x I_1^*\right]$$

$$P_e = R\left[|E'|\angle\delta(|Y_{11}|\angle-\theta_{11}|E'|\angle-\delta+|Y_{12}|\angle-\theta_{12}|V|\angle 0)\right]$$

or

$$P_e = |E'|^2|Y_{11}|\cos\theta_{11} + |E'||V||Y_{12}|\cos(\delta-\theta_{12}) \quad (2.20)$$

If value $\theta_{11} = \theta_{12} = 90^0$, and $Y_{12} = B_{12} = \frac{1}{X_{12}}$, will

$$P_e = |E'||V||B_{12}|\cos(\delta - 90^0)$$

or

$$P_e = \frac{|E'||V|}{X_{12}}\sin\delta \qquad (2.4$$

III. Method Of Research

The extended equal area criterion was applied to study the transient stability of the electric power system presented in Fig. 3 [lo]. A three-phase fault in some of the transmission lmes that" are connected to the generators busbars was simulated. The same fault was also simulated in line 6-8 near the load busbar 8. Near the busbars 9 and 10 the effect of the disturbance was not analysed, since the critical clearing tlmes that can be obtained are greater than 1 .O s [1 11. For each one of the above fault disturbances the study was cameout ctsnsidering all the synchfonous machmes connected. It was also analyzed the mfluence of the selective tripping of one or more generators in the transient stability of the power network, The fault clearing times were specified greater than the critical clearing time to analyzed the influence of the generators tripping m the transient stability.

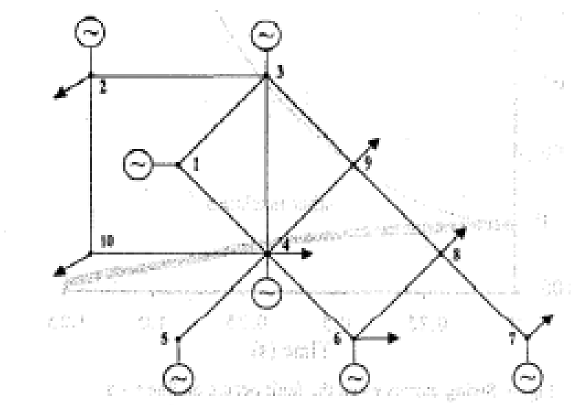

Figure 4. Electric Power System

Table1. Transmision Lines Data

Line	Resistance	Reactance	Susceptance
1 - 3	0.0099	0.0484	0.1013
1 - 4	0.0099	0.0484	0.0506
2 - 3	0.0450	0.1237	0.1013
3 - 4	0.0119	0.0780	0.1519
4 - 5	0.0040	0.0198	0.1013
4 - 6	0.0075	0.0198	0.6075
7 - 8	0.0119	0.0780	0.1519
6 - 8	0.0188	0.0628	0.1013
8 - 9	0.0488	0.1916	0.1013
3 - 9	0.0115	0.0553	0.1013
4 - 9	0.0488	0.1916	0.1013
2 - 10	0.0164	0.0638	0.1519
4 - 10	0.0164	0.0652	0.1519

Electrical power system model that concerns the stability problem is taken from the single line in the power plant Sicanang to PLTG Paya Pasir. In electric power system consists of two machines where engine 1 as a power generator (generator) in PLTU sicanang and machine 2 installed on Infinite bus that is in PLTG Paya Pasir, two Transformer each transformer 1 as step up (Step Up) In PLTU Sicanang and transformer 2 as step up (voltage) in PLTG Paya Pasir.

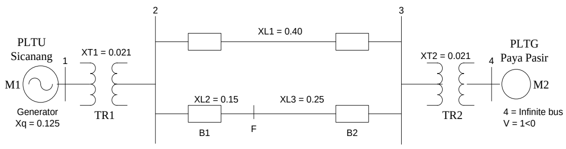

Figure 3. *Single line pada saluran transmisi dari PLTU Sicanang sampai ke PLTG Paya Pasir*

M1, M2 = Generator dan *Infinite* bus
TR1, TR2 = Power Transformer
B 1, B2 = Circuit *Breaker*
F = Channels that are interrupted

Tables 2. Reactance Channel

No	Parameter-parameter	Reactance (X) p.u.
1.	Reaktance generator (Xq)	j0,125
2.	Reaktance Trafo 1 (XT1)	j0,021
3.	Reaktance Trafo 2 (XT2)	j0,021
4.	Reaktance Transmition channel 1 (XL1)	j0,40
5.	Reaktance Transmition channel 2 (XL2)	j0,15
6.	Reaktance Transmition channel 3 (XL3)	j0.25
7.	Load reference voltage	$1{,}0\angle 0^0$

With the infinite bus (bus 4) in this system absorbing power of S = 1.0 + j0,2 then we will determine the Clearing Critical Angle and Clearing Critical Time with the Assumption that H = 4, 37 MJ / MVA.

IV. Analysis Result.

To determine the critical clearing time we can enter any value above 0 seconds to 1 second, in this research time will be used are 0.25 seconds, 0.35 seconds, 0.40 seconds and 0.60 seconds.

1) Termination at 0.25 seconds:

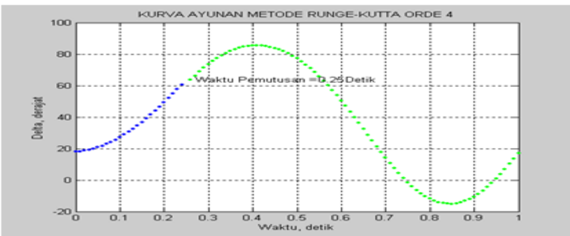

Figure 4. *The time-relation graph wye and delta at termination 0.25-second*

It can be shown in the graph that the break at 0.25 indicates a stable system because the graph indicates the swing. In a calculation of delta and omega price by Runge-Kutta method of order 4 using Matlab program showing an angle of termination less than critical breaking point (δp <δk) with value 60,6230 under or equal to 97,78320.

2) Termination 0.35 seconds :

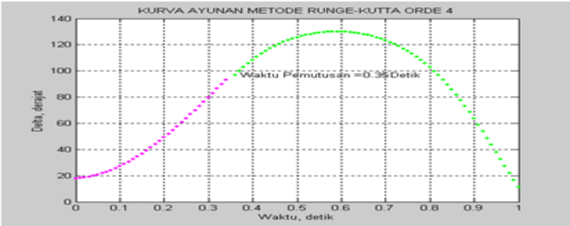

Figure 5. *A Greph Relation time wye and delta at termination 0,35 detik*

Seen in the chart that the break at 0.35 indicates a stable system because the graph shows the swing. In the calculation of delta and omega price by the method of Runge-Kutta order 4 using Matlab program shows the angle of termination less from critical breaking point (δp <δk) with value 93.3010 below or equal to 97,78320.

1) Termination at 0.60 Seconds :

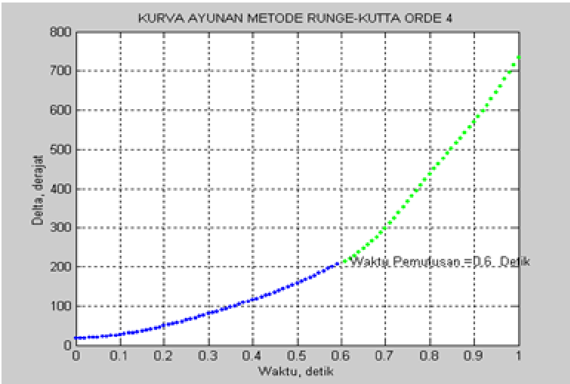

Figure 6. *A Graph Relation time wye and delta at termination 0,35 detik*

From the data results, the following conclusions can be extracted
- the solution obtained with the direct formulation used in this study is by the results calculated with the Runge-Kutta method;
- the selective tripping of one or more generating units after the occurrence of severe disturbances can be used successfully to improve the transient stability of the power system;
- if there is multi machine instability as it shown in table 5, the security of the power system requires the simultaneous tripping of one machine from the busbars of the critical set;
- the obtained values of the sudden increase in the electromagnetic torque of the remaining generators after one or more power units are tripped can be one of the parameters that in future work will be used to establish criteria to analyze the rotor shaft fatigue life.

V. Conclusion

From a result of calculation and alliance of stability of power system of authority plant of Sicanang Belawan with method of Runge-Kutta order of 4 using Matlab program got:

1. Termination at 0.25 seconds indicates a stable system because the graph shows the swing. The angle of disconnection is less than the critical breaking point (δp <δk) with the value 60.6230 below or equal to 97,78320.
2. Termination at 0.35 seconds indicates a stable system because the graph shows the swing. The angle of disconnection is less than the critical breaking point (δp <δk) with the value of 93.3010 below or equal to 97,78320
3. Termination at 0.40 indicates an unstable system because the graph does not show the swing. The angle of the disconnect angle exceeds the critical breaking point (δp> δk) with the value 111.3770 which should be below or equal to 97.78320.

4. Termination at 0.60 shows the system is not stable because the graph does not show the swing. The angle of disconnection exceeds the point of critical disconnection (δp> δk) with a value of 207.2500 which should be below or equal to 97.78320.

References

[1]. Cekdin Cekmas, 2006, "Sistem Tenaga Listrik", Penerbit Andi, Yogyakarta.
[2]. Dibyo H. L., 2008, "Studi Kestabilan Transient Sistem Tenaga Listrik Multimesin (Model IEEE 9 Bus 3 Mesin", Jurnal Teknika No.30 Vol.1 Thn. XV November 2008, Andalas.
[3]. Dibyo H. L., dan Suri A., 2012, "Studi Kestabilan Peralihan dengan Metoda Kriteria Sama Luas", Jurnal Teknika Vol.19 No.1 April 2012, Andalas.
[4]. Gross C.A., 1979, "Power System Analysis", John Wiley & Sons, New York.
[5]. Hanselman, D., dan B. Littlefield, 2000, "Matlab Bahasa Komputasi Teknis", Penerbit Andi, Yogyakarta.
[6]. L Bijang Nathaniel, 2012, "Analisa Waktu Pemutusan Suatu Sistem Kelistrikan", Jurnal Ilmiah Sains Vol.12 No.2 Oktober 2012, Politeknik Negeri Manado.
[7]. Ontosena Penangsang dan Sabar Setya Widayat. 2001. "Alalisa Stabilitas Transient Multimesin Dengan Metode Extended Equal Area Criterion", PPs ITS Surabaya.
[8]. S. H., Horowitz [et al.], "Turbine-Generator shaft torques and fatigues: Part I – Simulation methods and fatigue analysis; Part I1 - Impact of system disturbances and high speed reclosure". IEEE Transactions on Power Apparatus and Systems, vol. PAS-98, n.'6, Nov./Dec. 1979, pp. 2299-2328.
[9]. Y. Xue, [et al.], "Extended equal area criterion revisited". IEEE Transactions on Power Systems, vol. 7, n.' 3, August 1992, IEEE Task Force Report, "A description of discrete supplementary controls for stability", IEEE Transactions on Power Apparatus and Systems, vol. PAS-97 n.' 1, January 1978, pp.149-165.
[10]. M. A. Pai, Power System Stability: Analysis by the Direct Method of Lyapunov, Amsterdam, The Netherlands, North-Holland Publishing Company, 1981,~. 162-165. M. H. Haque, "Further developments of the equal-area criterion for multimachine power systems", Electric Power Systems Research, vol. 33,n."3, 1995,pp.'175-183. pp. 563-567. pp, 1012-1022.

Solly Aryza. "A Novelty Stability Of Electrical System Single Machine Based Runge Kutta Orde 4 Method ." IOSR Journal of Electrical and Electronics Engineering (IOSR-JEEE) 12.4 (2017): 55-60.