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Feed water system's optimization in thermal power plants (case study) by vector control inverters

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Abstract

By the day by day diffusion of electrical energy Consumption and product expenditure's increase, saving's need consumption, is felt rather than past.
Pump's systems averagely consume productive electricity near to 30% in industrial countries so that older pumps are usually moved via inductive motors and A - Synchron motors. (Mostly induction squirrel motors) and reluctant switch motors are recently used, too.
Electrical energy consumption of pumps is 31% in America.
Different studies have been showed that by optimizing pipelines, pumps and their control's systems their energy consumption can be saved between 30 % to 50%.old control systems cannot be effective in improving energy consumption .using variable velocities drives by the help of electrical power is used for improving energy consumption .also electrical power Inverter's source is investigated in pump's drive reluctancy.in most plans, during a pump self-life's time, half of the expenditures are related to the electricity consumption .
Although the early expenses of purchase and pump installation includes 10% of the whole expenditure, logic use of energy, conservation of energy resources, the amount's reformation of energy consumption in consuming parts of energy, reduction of greenhouses gas and air pollution's reduction, reformation of existent case and competitive excellence in economical establishments, can be expressed as the purposes of optimization of energy consumption.
Power plants as forerunners of products can play an important role by optimizing new systems or by reforming them. Against this intention, for increasing the efficiency of a 1300 megawatt unit and according to not using drive system in this unit's pumps, the beneficial use of this system is mentioned, and economically by considering load's profile has been investigated.

Key words: power plants of feed water system, thermal power plant, feed water module of thermal power plant, vector control

1- **Introduction**

Transmuting an existent fuel in nature like coal and natural gas and mazot in to the thermal energy is the most important happenings in the steam power plant .that this happening occurs inside the boiler .dram's level control in boiler of thermal power plant, as resistance of electricity producer module and the consolidation of power's network has a very especial importance.

This dissertation primarily is set to investigate feed water system's boiler of thermal power plants. and the ways of feed water boiler such as classical and modern has been analyzed and also their Efficiency by external curved pressure of water is analyzed and have been compared

with one another, henceforth, the way of feeding water boiler of thermal power plants is introduced that includes the less casualties.

This way proportionally to the amount of needed pressure provides the best Efficiency in each moment in contrast to the oldest ways .and the resumption of another way that is according to the existent systems in thermal modules is introduced, which can have the best Efficiency and the best style according to the transformation of mechanical to electrical with the less expenditure and the less changes.

At last, by extracting efficiency's ways of controlling classical water pressure and also simulating modern ways and the use of innovator controlling instead of hydraulic coupling system and gearbox with complete changes and putting an electromotor with the ability of changing around the pump's base or using innovator instead of hydraulic coupling and electromotor by a fixed whirl and gearbox and actually with having less changes in a power plant of 1261 megawatt.

All these ways have been contrasted with each other and the efficiency, casualties and the power of consumption of each one have been compared, too.

In addition of increasing the efficiency by using clear-cut ways, in this dissertation, feed water system of thermal power plants can be expedited to have electrical feed water system automatically and also decreasing manpower′s interference in dangerous mechanical systems.

2-Ways of controlling Debi′s feed water system

Feed water pump is an inseparable and fixed part of the rank line’s circulation in steam power plants. Pressure and the Debi of this pump must answer the most need of continuous product′s module and in addition; it must cover non-continuous module of peak′s load, too. Besides, for increasing accessibility′s coefficient and the more trust′s ability of Debi’s amount usually it is provided by 2 pumps which are set as a shape of parallel and the third pump will set as a booking. Generally, there are 3 ways of uses with variable circulation for injecting a suitable amount of it to storage which is beneath pressure.
1. Reversible tap 2 .controlling tap 3 .pump
Current power plants use the first way just in initiation and low pump Debi, and 2 other ways are used simultaneously.

1-2 use′s way of reversible tap

In this way, extra water amount′s need of steam boiler in pump′s exit will be returned through a controllable tap into weathered storage.

As it is shown in picture (1): the pump′s function point and its energy consumption was fixed and it will be just in one point of optimum energy consumption's function and maximum Efficiency and the more Debi’s needed boiler from the maximum point of permanent produced is lessoned and the more casualties will be.

As an example: produced hydraulic energy amount was equal to the A Debi′s amount by pump level′s equivalence (4-3-2-1).it is when the needed energy was equal to level (7-6-a-4) in this Debi and energy level′s equivalence of (a-1-2-8) has been wasted by reversible tap and also energy level′s equivalence of (3-8-6-7) won′t be beneficial, either.

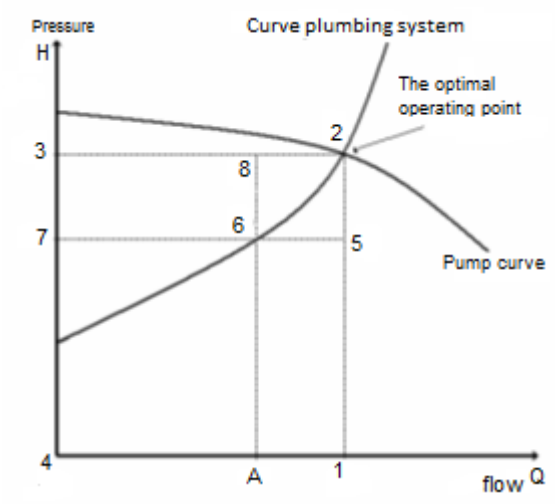


Figure 1 shows how to use a reciprocating valve

2-2 control′s tap or damper tap′s way

In this way by putting a controllable tap in Debi's pumping way, the going water will be controlled and as regards, by creating resistance in the fluid passing way, whilst behavior's change of pumping′s curved, part of hydraulic fluid energy waste as heat-sound ,flutter and tenseness.

For instance, in picture (2) if Debi's amount of needed water is A, the function′s point will be changed from point 3 to the point 5 by a little closing tap.

In this way, the consumed hydraulic energy is equal to the level of (6-5-a-1) by pump. While needed energy of steam boiler was equal to the level of (8-7-a-1) and the differences between these two levels is equal to the wasted energy in this function′s point.

3-2 pump′s way with variable circulation

Curved pump can be moved in the length of axis pressure by a change around the pump and can reach a new function′s point through pumping′s curved.

In this way ,the produced hydraulic energy coincide with needed energy of pumping′s system in appointed Debi by pump and as regards, feed′s system will always function near to the maximum′s point of Efficiency.

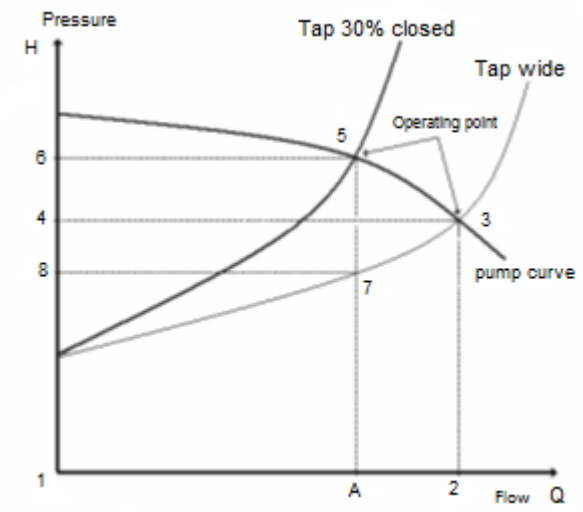


Figure 2 shows how to use a closing valve

1-3-2 feed water system by the use of pump′s variable circulation

There are 2 ways for pump′s circulation:

In first way, coupling control via adding mechanical parts of powers transmitters is done from producer's torque system to the pump. However, very classical and old parts of torque's control like strip′s cone or monetary and strip still exist in some small power plants, and it′s working but these systems are obsolete in new steam′s power plants and they are also changed with hydraulic coupling.

In second way, controlling the torque is done in torque producer's system. This way is usually used in cases that torque's generator is a steam turbine and by controlling intake steam's amount into turbine, torques amount and its circulation can be controlled.

Although because of many problems of the first way, this way is used in some big power plants and exclusive power plants in especial industry, but because of very high expenditures of formation, utilization and conservation in steam power plants, it is not generalized.

Nowadays, the first way, namely mechanical torque's control in mechanical power transition's system is used in most steam power plants.

Torque's generator is a big multi megawatt inductive motor in this way. Several parts of this way are gearbox system and hydraulic coupling.

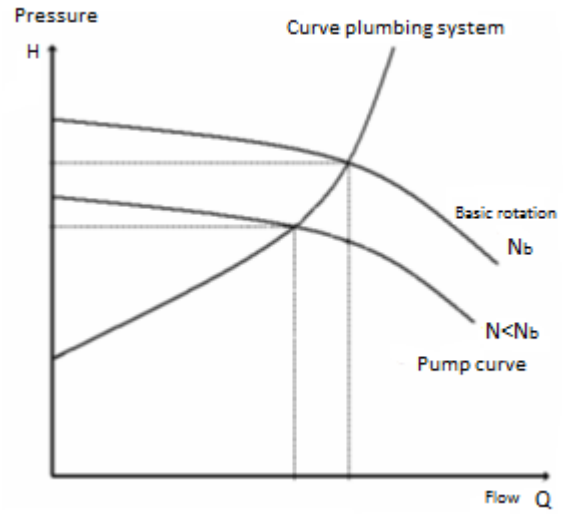


Figure 3 shows the use of pumps with variable speed

A big inductive motor with fixed circulation (forbearing from flutter amount) is used as a mechanical torque in existent power plants. Inductive motor's circulation in gearbox is increased into pump level's circulation and then by controlling transitional torque in hydraulic coupling's system, suitable torque in appointed function's point is transmuted into pump and pump's circulation in appointed function's point and maximum of possible Efficiency is controlled.

For creating this model that is shown in picture 4, produced ability in power plant is entered as power plant function's point into steam boiler's model and it will create a permanent situation in needed water amount's exit of steam boiler. This amount of water actually is water Debi that exits from pump so that is entered to the pump's model as an intake. Afterwards hydraulical ability and needed circulation is created for conserving function's point of system in the maximum of possible Efficiency and it is put in the exit of pump's model.

This ability should pass coupling and as regards, needed torque will be entered coupling model. At next step, decreased energy due to transmuting ability will be produced from gearbox and finally needed coupling that must be produced via inductive motor, will be specified.

The consumption energy of inductive motor will be ultimate in exit motor's model. The casualties in separation of each part in needed function's point is shown in each part of this model and as regards, consumption ability ,general Efficiency and each part of Efficiency will be ultimate from system.

The real feed of existent power plants in a system, indeed, is used from a real way of reversible tap for initiation and low load and damper tap's way is used simultaneously by the way of torque's control, because of coupling control's system in transmuting way of mechanical ability.

That in this dissertation, adding these parts are forbore because of preventing model's complexity.

2-3-2 Recommended model of feed water system by minimum changes in new power plants

This model that is recommended for feed water system in new power plants, control′s torque task and pump′s circulation setting is sponsored by producer′s torque namely inductive motor. So, there is no need of coupling system and subset′s parts of oily cooler systems and oil′s steams purification of cooling tower and … and there isn't any gearbox, too. But the inductive motor of producer′s torque must have function′s ability around the motor′s base.

2-3-3 feed water′s model via electrical power Inverter′s use

Since finding suitable solution for optimizing existent power plants with minimum changes is one of the purposes of this dissertation, thereupon, another model for this function is recommended so that there is no need of changing inductive motor. So, the gearbox must be used for inductive motor circulation′s increase around the pump′s base. In contrast to the first model, hydraulic coupling system and its parts are deleted and like the second model that control′s torque task will be sponsored by the inductive motor.

Possibility of uses in existent power plants by the minimum of changes expenditure is the benefit of this model. Because of using existent steam from coupling way and electromotor with fixed circulation and for using way's control circulation via innovator, and complete delete of mechanical system like gearbox, needing motor by circulation′s ability around the pump′s base; according to the situation, the electromotor must be changed to another one that has got the ability.

For preventing this point, a gearbox will be fixedly put for increasing two motors and just the coupling will be changed with an innovator so that it can sponsor electromotor control′s task.

3- Different models of feed water system and enquiry of efficiency and casualties in different ways

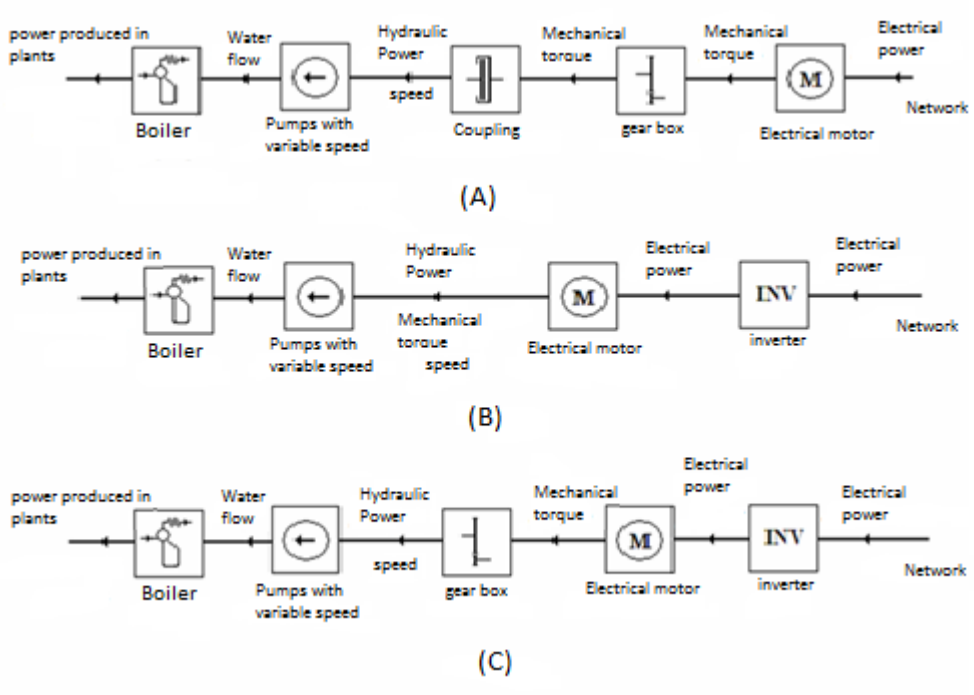


Figure 4 models feed water system

The A way is a kind that is performed nowadays in most power plants. The water reaches booster by 12 times through suction and the booster increases the pressure′s pump by 40 times, then motor′s circulation will reach pump′s base circulation via gearbox and at this time, hydraulic coupling′s task is coupling electromotor with pump and namely electromotor circulation′s control and by increasing electromotor circulation of water pressure, it will approximately be augmented to 5 evens.

In B way which is a changeable one, both coupling and gearbox must delete. (And electromotor with fixed velocity should be replaced with variable motors) and an innovator is put for initiation and circulation control.

In C way, there is no need of essential changes as B model. Also it can have the best efficiency proportionally to the use′s way of coupling by deleting coupling′s system and substituting innovator for motor′s initiation. As it is shown in amounts table; it is the best efficiency for the way of innovator′s use. (but) according to have the best efficiency in the minimum of changes, a gearbox can fixedly have the cycle for increasing electromotor circulation around the pump′s base and actually coupling must be deleted, and instead of that an innovator must be put for motor circulation's control.

4- Simulating recommended ways for optimizing existent power plants

In the recommended way, by the name of changes and conservation of the gearbox and motor, and substituting the innovator instead of hydraulic coupling, is seen in table 3 that the Efficiency of this way is proportionally better than the mechanical way, but it has the less efficiency proportionally to the complete substitution of innovator instead of mechanical system, and electromotor changing that was shown in table 2.

But it has this benefit that it will noticeably increase by minimum of changes and less efficiency's expenditures.

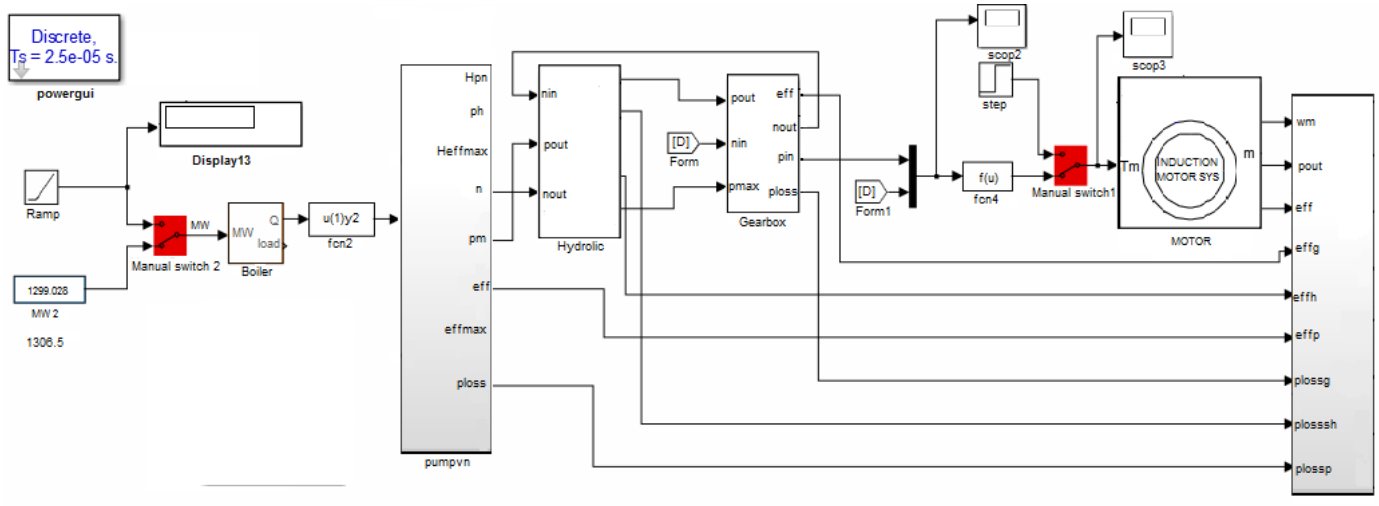


Figure 5 simulates traditional feed water system in thermal units

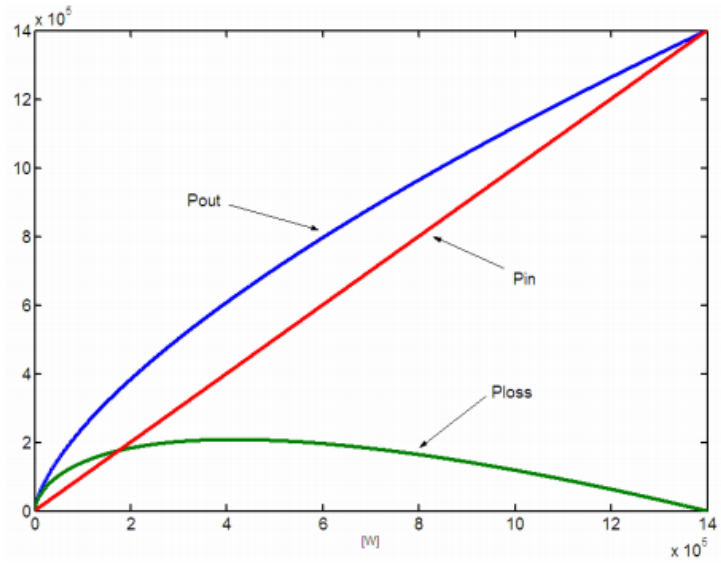


Figure 6 losses in the system diagram Coupling

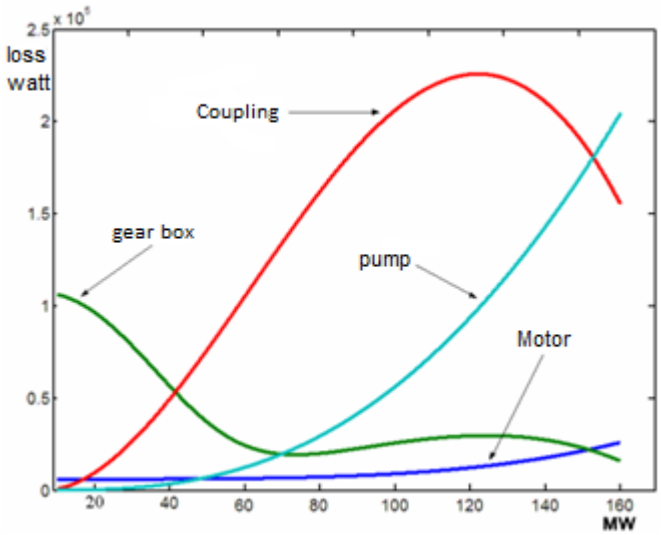


Figure 7 Figure casualties mechanical system components with different loads

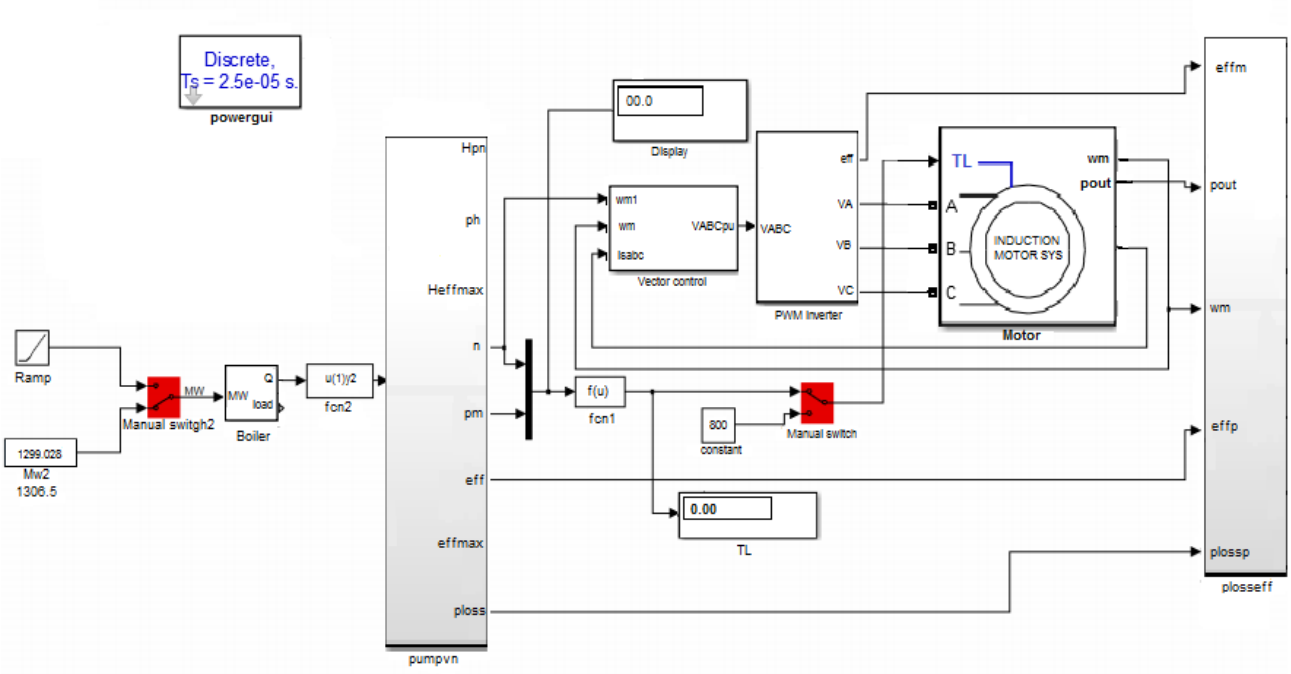


Figure 8 shows a simulation of the proposed feed water system in thermal unit (inverter with the gearbox, followed by complete removal of the mechanical system)

Title	Unit	Contrasting different way's Efficiency of feed water′s control

producing percent of power plant	%	25	50	75	100
Produced power by power plant	MW	325,013	650,027	975,041	1299,028
Reversible tap′s way	%	12,77	25,99	42,56	64,1
Damper tap′s way	%	20,68	37,77	54,81	71,81
pump′s way with variable circulation	%	77,14	79,65	81,21	82,27

Table 1-Contrasting feed water Efficiency in different ways

It is obvious in table 3 that fix circulation of pump′s way which includes using hydraulic coupling and electrical power Inverter or both together, have a very high efficiency proportionally to the mechanical ways of water Debi′s control.

Contrasting two ways of controlling by hydraulic coupling and a complete exchange of coupling and mechanical system and electrical power inverter.

Title	Unit	Contrasting the Efficiency and two ways of variable pump's casualties

producing percent of power plant	%	25	50	75	100
Produced power by power plant	MW	325,013	650,027	975,041	1299,028
whole Efficiency power in coupling way	W	1208802/24	1977922/8	3225969/72	4051643/22
Whole Efficiency of coupling way	%	10,15	31,56	46,92	61,22
Whole wasted power in electrical Inverter (changing electromotor)	W	42107/04	238380/84	671732/46	1391050/8
Whole Efficiency in electrical Inverter (changing electromotor)	%	67,17	73,94	77,10	79,06

Table 2- contrasting two ways of variable circulation′s pump(Compare the changing motor way and inverter switching and coupling)

Title	Unit	The Efficiency and causalities of the innovator substitution model with the gearbox

producing percent of power plant	%	25	50	75	100
Produced power by power plant	MW	325,.13	650,027	975,041	1299,028
Whole wasted power in this way	W	319137/3	344694/96	832701/6	1627749
Whole Efficiency in this way	%	29,89	72,57	76,13	79,72
Whole wasted power in coupling′s way	W	1208802/24	1977922/8	3225969/72	4051643/22
Whole Efficiency of coupling way	%	10,15	31,56	46,92	61,22

Table3- reformation of way′s amount of feed water system in existent power plants(Compare method of connection and switch the inverter and coupling with minimal changes)

Important differences of initiating can have the considerable disadvantages and massive advantages in this gigantic power period.
There exist a powerful and tremendous current in this range when generating electromotor directly to the system.
(A) current six times more powerful than so called current in 30 seconds
This huge current is the cause of transformer's module measurement- keys – cables and the complexity of motor's conservation that has transformed, and in addition to that, it will create limitations as regard of unsuccessful initiation way and the absence initiation of huge consumers in power plant.
At last, the voltage slippage of domestic load is unavoidable at the time of named motor's initiation in power plant.
(Network voltage will decrease up to 0,875)

5- Conclusion

Water feed system's efficiency increase is the cause of whole power plant Efficiency's increase in using control's Inverters of large inductive motor instead of mechanical way of hydraulic coupling, and especially the casualties will be decreased by variable load in power plant. However, harmonic problem is an innovator's problem in innovator's exit, there are different ways for deleting them like: using multilevel innovators that this way is possessed execution in power plant with existent conditions by the least expenditure and changes.

And also perilous systems of many mechanical expenditures is deleted by these condition's creation so that by this action, environmental optimization will include deleting pollution due to oil's steam.

Actually optimization's ability is done without changing electrical motor and just by deleting hydraulic coupling via existent power plants.

Provided that a power plant's load in low load's condition is (25% loads) at 8 hours circadian, 12 hours in normal load (75% loads) and 4 hours in pick load (100% loads), average Efficiency will be 37% in hydraulic system and 61% in electronic Inverter's system.

If we consider this problem for all country's power plants, we can prevent 580 million kilowatt hours from wasting in power plants in a year that this amount is equal to 120 megawatt and it will also prevent it from a noticeable fuel amount's burning and air pollution.

The plan is examining high levels innovators like upwards of 50 levels, and its advantages and disadvantages must be evaluated and an optimum structure should be presented as regard of numbers, ingredient's mass, minor harmonic, outputs and expenditure.

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