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Forecasting Maximum Demand And Loadshedding

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ABSTRACT
The intention of this paper is to priorly estimate the maximum demand (MD) during the running slots. The forecasting of MD will help us to save the extra bill charged. The MD is calculated by two methods basically : graphically and mathematically. It will help us to control the total demand, and reduce the effective cost. With help of forecasting MD, we can even perform load shedding if our MD will be exceeding the contract demand (CD). Load shedding is performed as per the load requirement. After load shedding, the MD can be brought under control and hence we can avoid the extra charges which are to be paid under the conditions if our MD exceeds the CD. This scheme is being implemented in various industries. For forecasting the MD we have to consider various zones as: load flow analysis, relay safe operating area (SOA), ratings of the equipments installed, etc. The estimation of MD and load shedding (LS) can be also done through automated process such as programming in PLC's. The automated system is very much required in the industrial zones. This saves the valuable time, as well as the labor work required. The PLC and SCADA software helps a lot in automation technique. To calculate the MD the ratings of each and every equipment installed in the premises is considered. The estimation of MD and LS program will avoid the industries from paying the huge penalties for the electricity companies. This leads to the bright future scope of this concept in the rapid industrialization sector, energy sectors.

Keywords – maximum demand, contract demand, load shedding, relay safe operating area,load flow analysis, PLC, SCADA

I. INTRODUCTION

The project is designed to develop a PLC programming for forecasting maximum demand and load shedding scheme. Various PLC's are available in the market according to the requirement. The PLC which one is used during this project is Allen Bradley. A programming is developed so that forecasting of MD can be done and accordingly LS(load shedding) can be performed as per the customer need.

Electricity is the basic requirement for any industry to continue its production. Therefore good quality and with affordable rates electric supply is always in demand from the suppliers. To have a proper electric supply from the electricity supply companies various schemes are being allotted, such as time of day tariff (TOD), by this the consumers can shift their loads during non peak hours and can have benefits in his electricity bills accordingly. Large scale industries require continue supply of electricity, as these industries consist of critical loads which are required to be continuously fed, any abruption of supply may lead to its malfunction and give a tremendous loss to the owner which is not affordable in any case. The electricity supply may not be continuous all the times there may be various fluctuations in the supply due to various reasons. Hence, to avoid this condition maximum demand (MD) concept plays an important role.

While calculating the maximum demand for any plant we have to consider its total load, as well as each and every equipment installed in the premises. The rating of every equipment are being noted down and is used for further analysis. The total load flow analysis is being divided into many parts.

Maximum demand can be calculated in different ways. Basically we have considered two different ways for the easy calculation of MD:

1. Graphically
2. Mathematically

In graphical method, we are plotting a graph between load and time (30 minutes) slot. The contract demand (CD) is constant in this graph. When our MD curve is found to be exceeding the CD value, immediate actions are taken and the MD value is brought down under controlled value. This leads to prior estimation of maximum demand, and to control this MD load shedding is performed.

II. MAXIMUM DEMAND CONCEPT

Maximum demand is the capacity of electricity usage, and its work to assess the level of capacity (load) of electricity used by consumer. MD is measured in Kilo Watts, and it is calculated as double

the highest amount of electricity used (in Kilo Watt-hours) within any consecutive period of thirty minutes in a month. The calculation of maximum demand varies depending upon customer tariff categories. However, it is only applicable to the customer using a supply of 6.6 KV and above.

There are three terms that appears on electricity bill

1. Active energy consumption (KWh)
2. Reactive energy consumption (KVARh)
3. Maximum demand

Traditionally, utility companies have concentrated their energy saving efforts on two items:

1. Reduction of Kilowatt Hour consumption
2. Improving the electrical system's Power factor

There is a third item to be considered when reducing the amount of electric company bill, proper KW demand management which allows:

1. Reduction of contracted power
2. Adjusting to the new KW limit
3. Avoiding the KW demand penalties

MD is the power consumed over a pre determined period of time, which is usually between 8- 30 minutes. The most common period of time, in the majority of countries is 15 minutes. This power is calculated and billed by a KW demand meter, which records the highest KW value in one 30 minute period, over a month's time.

III. CALCULATING MAXIMUM DEMAND

There are several different ways to calculate MD:

1. Fixed demand (Blocked demand)
2. Rolling demand
3. Time synchronisation window
4. Thermal demand

These various methods help in estimating the maximum demand.

GRAPHICAL METHOD:

It is very common method used. The graph is plotted between the load and time. Time is of 30 minutes slab. Load variation pattern for any industry is 8 hours.

In this method the contract demand (CD) is kept constant. Every second reading is plotted in a 30 minutes slab. These readings are then integrated ad then doubled to find out the readings for one hour slot. If it is found that our MD is exceeding the CD value, we take out certain preventive actions to bring down the MD value from the CD value.

The following graph will help us to easy understand this concept:

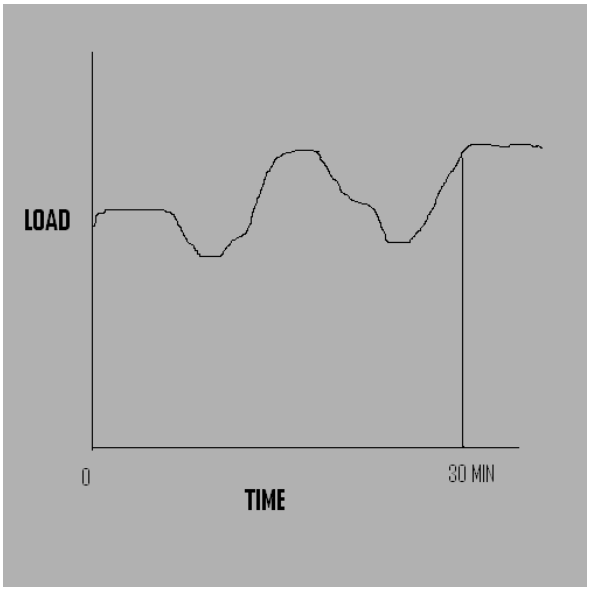

Fig.1:-Graph Load vs. Time

The graph is for 30 minutes slab. Here, MD is expressed in KVA. The maximum demand will be defined as: "Average KVA over the period of 30 minutes slab" for the total month.

Now, average KVA over 30 minutes slab is calculated as: Area under the curve divided by the time, as shown in the graph.

MATHEMATICAL METHOD:

In this method of calculation, load flow analysis (LFA) is carried out. The power is calculated by the formula:

$P = \sqrt{3}VI cos\theta$

Where, P= Power, V = Voltage of the system, I= Current on the system, $cos\theta$=Power factor of the system. For understanding, consider an example: Let us consider a month of 30 days; therefore there will be 14440 slots of half an hour. For each half an hour, average KVA is calculated and recorded in a meter. Out of these 14440 records, maximum value recorded is the MD for that period of a particular month.

The calculation is as follows:

The total readings are being integrated over a period of 0 to 30 minutes slab. Mathematically it can be calculated with formula as:

$$\int_0^{30} L\frac{dL}{dt}$$

Where, L=load, T=time (0 to 30 minutes)

Hence, by above two methods it would be easy to calculate the MD for any operating utility.

IV. HOW THE MD EFFECT THE BILL?

The example discussed below shows how excess power consumption affects the electric company bill: let,

Contracted power = 136KW
KW meter reading = 253 KW
Maximum demand calculated without surcharge=136 KW ×1.05 =142.80 KW
Excess power consumed= 253KW−142.80KW =110.2 KW, therefore,
KW penalty = 110.2KW×2 = 220.4 KW.
Total KW to be billed = 220.4KW +253KW = 473.4KW. Proper management of KLW would not have allowed 136 KW to be exceeded and 205.1€ would have been charged instead of 713.28€ i.e. 71.25% less.

The above example concluded that MD plays an important role in billing; hence in any industry we can forecast the MD for saving money.

METHOD OF OPERATION:

There are two methods to avoid excess maximum demand:

1. Preventive: This method is suitable for those companies who do not want to allow automatic connection or disconnection of load. The system operates using audio or visible alarms indicating that KW demand limit is going to b e exceeded and that an operator should manually disconnect certain loads.
2. Predictive: This is most often used method. The unit predicts that what is going to happen based on the load at the end of the current period and optimizes the load in order to have as many loads connected without exceeding the maximum demand limit, which is present in the unit. This method of control is used when calculating demand using the fixed or synchronized demand methods.

V. CONTROL OF MAXIMUM DEMAND:

The purpose of controlling MD is, not to exceed the contract demand (CD) limit. If the MD is found to be exceeding the CD within the half an hour slot immediate actions are taken. If the MD is not controlled and it exceeds the contracted figure, penalties are imposed on the companies which are not affordable. Hence, immediate actions are to be taken to avoid this condition. One way to do this is to shed non critical loads. Possible loads disconnected could be:

1. Light
2. Compressors
3. Air Conditioners
4. Pumps
5. Fans & Extractor
6. Packaging machinery
7. Shredders
8. Others…

Generally, all those machine which do not affect the main production process or which are not essential. In addition to controlling KW demand, following equipment is suitable for processes which have larges KW demand and low loading factors, such as companies in the smelting, mining, automobile, textiles, paper industries, etc.

EQUIPMENT TO CONTROL MAXIMUM DEMAND:

Measurlogic offers all necessary equipments for optimum energy/ demand management. The following equipment measures instantaneous power and automatically calculates and determines if and when the KW demand will exceed limit set forth by utility company. This is done by reliably disconnecting and reconnecting non critical loads using relays which are built into equipment. The CVM-R8CPP and CA-4 can also be programmed with different tariffs (Time Of Use Periods) to shed loads with different contracted limits.

VI. LOAD SHEDDING:

Load shedding is the term used to describe thedeliberate switching off of electric supply to parts of the electricity network, and hence to the customers in those areas. Conventional methods of load shedding were too slow and did not correctly found out the correct amount of the load to be shed. This resulted in excessive or deficit load shedding. In modern period, load shedding system is improved using conventional under frequency relay, breaker inter locks schemes integrated with Programmable Logic Control. An modern and intelligent load shedding system with a computerized power management system should be fast and optimal load management.

In general, load shedding can be defined as the amount of the load that must be removed from power system to keep the balance system in operating condition.

Load shedding normally can be done in two ways:

1. Automatic load shedding: It usually occurs on transmission system level, with result being large amount of electricity and large blocks of customers taken off supply in very short time.
2. Manual (selective) load shedding: This occurs where time is available (usually up to 30 minutes) to make selective choice on which loads to be shed.

LOAD SHEDDING THROUGH PLC:

Due to drawbacks of conventional system, an intelligent load shedding system is necessary for improving the response time, make fast, correct and reliable load shedding decisions.

As industries are being automated at large scale, therefore PLC'S are very often used to improve the system reliability. PLC, SCADA both offers a great relief in this sector. The PLC and SCADA used

during our project is of ALLEN BRADLEY (ROCKWELL). When MD is found to being exceeding the contract demand, then according to the programming developed, PLC takes the decision of load shedding and loads are being cut down until the MD is brought down to the set value.

Every industry has critical as well as non critical loads. The priority of the load varies as per the requirement. Therefore the load shedding programming should be flexible so that the load priority can be changed accordingly. Under the condition of load to be shed, the load given as highest priority are to be shed first, which are the most non critical loads. Remaining load should be cut down according to their priority. The loads are cut down until the MD dopes not reach a safe value and then the process is stopped automatically. Once our MD is below the targeted points then the shaded loads are again brought in the continuity.This scheme is very beneficial and as industrial sector is growing rapidly, the forecasting of maximum demand an d load shedding scheme have a better future scope

VII. CONCLUSION

The paper concludes that load shedding in industrial power system severs as a protection cover to save the system from sudden abrupt changes. The paper point out the importance of new PLC technology in this area. Forecasting of maximum demand and simultaneous load shedding as per the requirement can reduce a large amount of loss. It can reduce the electricity bill to a great extent and can also help to avoid imposing of penalties.

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