NCB STUDY ON EFFECTS OF QUALITY OF POWER ON PRODUCTIVITY IN CEMENT PLANTS

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1. INTRODUCTION

Cement industry in India is one of the largest consumers of power. It is expected to consume about 6 billion kWh of electricity for the present target of 42.5 million tonnes of production. The requirement of power would further rise to 14 billion kWh by 1999-2000 as the installed capacity increases. In addition to the availability of power in the required measure, its quality plays a vital role in achieving better production. For continuous operation and full capacity utilisation, besides maintenance of quality of product, cement plants require uninterrupted power supply free from fluctuations of voltage and frequency. But the shortage of power and its poor quality has placed numerous constraints in achieving high capacity utilisation and productivity in cement plants. However, installation of captive power plants in a few cement plants has solved the problem to some extent and the effect of power cuts or interruptions on production has been considerably mitigated.

2. QUALITY OF POWER

The various factors which constitute the quality of power are:

— Number and duration of power cuts
— Number of power interruptions and trippings
— Voltage fluctuations below the rated value
— Frequency variations

All these factors, singly and collectively, have their own effects on the productivity of cement plants.

NCB has conducted studies in a large number of representative cement plants to assess the problem and devise measures to combat it. The studies indicate that, on an average, the power cut is about 42% of the maximum demand, rising at times to as high as 80% (Fig. 1). It is also observed that the frequency of interruptions varies from once a month to 1-2 times a day. Low voltages of up to 30% of the rated value are being experienced by some of the plants (Fig. 2). In spite of the fact that low voltage limits specified by the Bureau of Indian Standards (BIS) is only 6%, in actual practice 10 - 15% values are common. Similarly the frequency variation specified by BIS is 3% but in practice 6-8% frequency variations are common.

3. EFFECTS OF POOR QUALITY OF POWER

NCB studies reveal that poor quality of power has the following adverse effects:

a) Loss of production
b) High energy consumption
c) Reduced refractory lining life
d) Poor quality of clinker
e) Reduced life of motors, plant and machinery
f) High environmental pollution.

3.1 Loss of Production

It is observed that even a short stoppage of kiln, due to power interruption, leads to considerable production loss. The loss in production for different durations of power interruptions in the case of dry process plants of 3000 tpd, 1700 tpd and 900 tpd capacities is shown in Fig. 3.

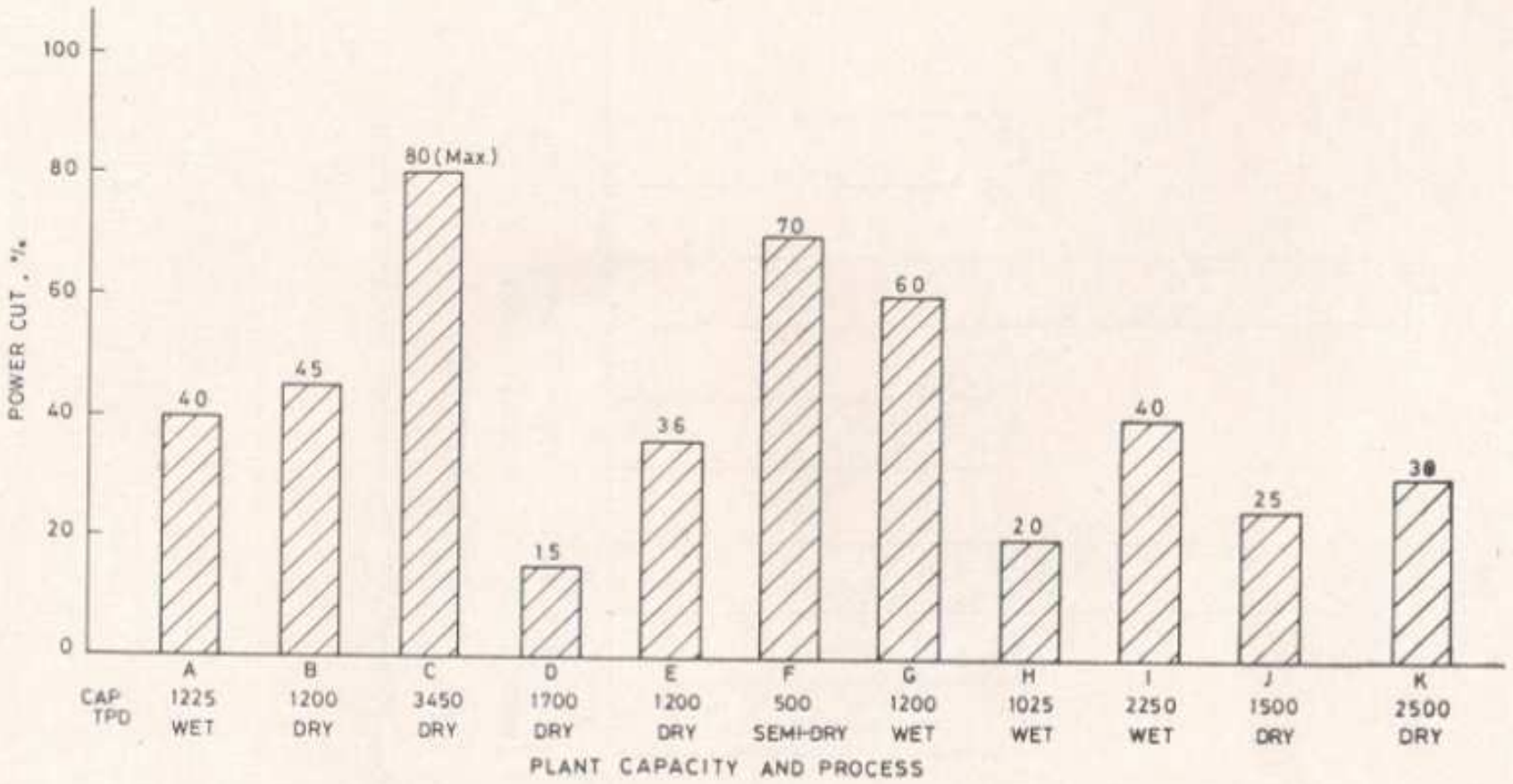

Fig. 1 Average Power cut as percentage of Contract Demand in Cement Plants

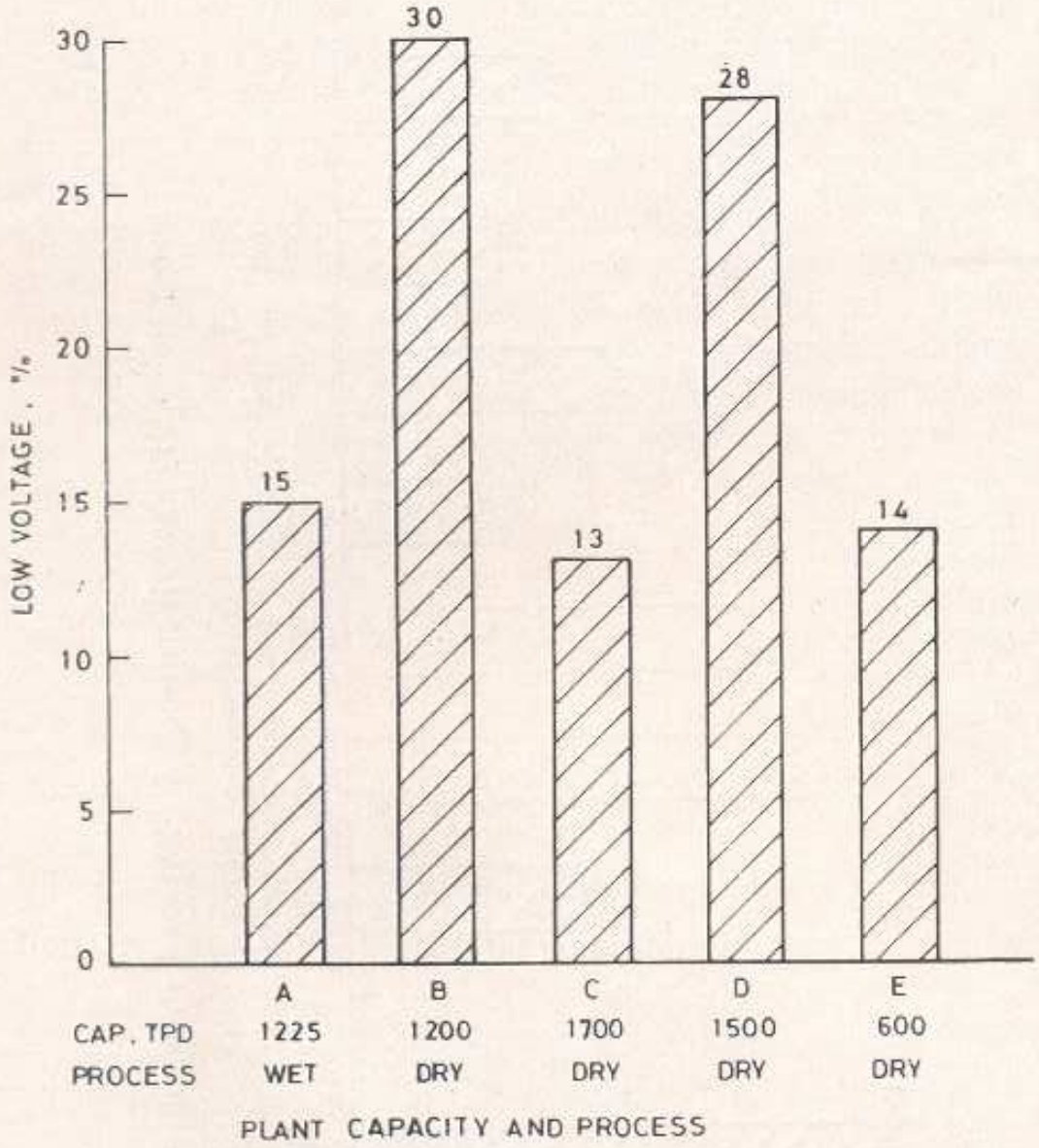

Fig. 2 Low Voltage (%) Encountered in Cement Plants

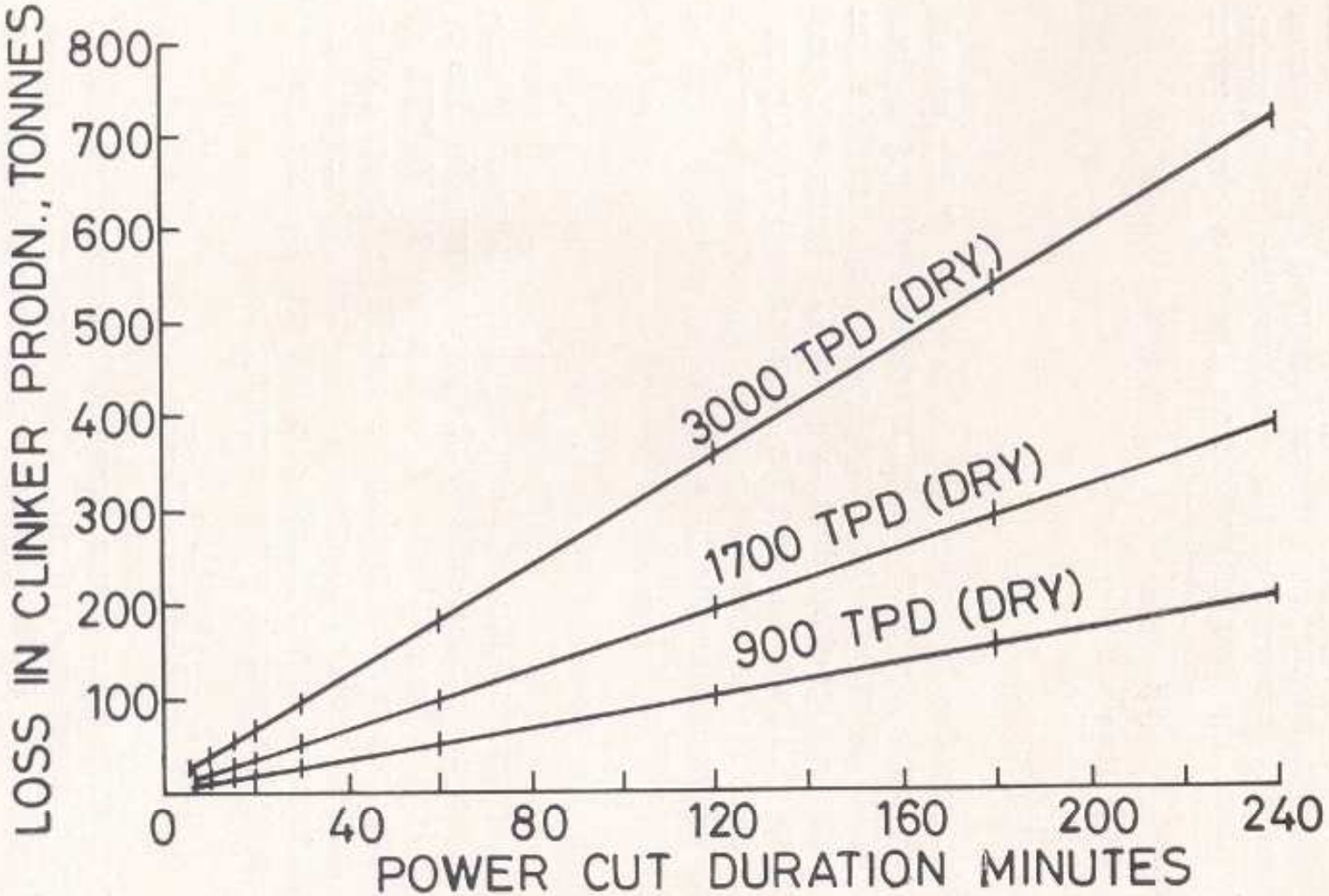

Fig. 3 Effects of Power cut Duration on Production Loss

Apart from the duration of power cuts, their number has been found to affect production adversely. For example, in a typical case it was observed that 20 power cuts of five minutes duration each resulted in approximately twice the loss of production due to a single power cut of 100 minutes duration.

3.2 High Energy Consumption

3.2.1 *Thermal Energy*

Heat loss due to power cuts in the case of dry process plants of capacities 3000 tpd, 1700 tpd, and 900 tpd is given in Fig. 4. However, the graph, which is a straight line for power cuts of short durations, say 4 - 6 hours, will tend to curve with reduced slope for longer durations of power failures. It can be seen that a power cut of one hour in a 3000 tpd plant amounts to a loss of as much as about 4 tonnes of coal.

3.2.2 *Electrical Energy*

It is found that the high starting current drawn by motors alone, on account of 2 - 3 stoppages every day due to power failures, accounts for approximately 10000 kWh of additional power consumption per month in the case of a kiln and mills of a 1200 tpd (dry) plant. Moreover, the output rates of kiln and mills also fall greatly, thus further increasing the specific power consumption.

3.3 Reduced Refractory Lining Life

Apart from other causes, frequent kiln stoppages due to power interruptions seriously affect the durability of refractory lining. While a power cut of very short duration (say a few minutes) may not have a serious effect, a cut of longer duration does adversely affect refractory lining

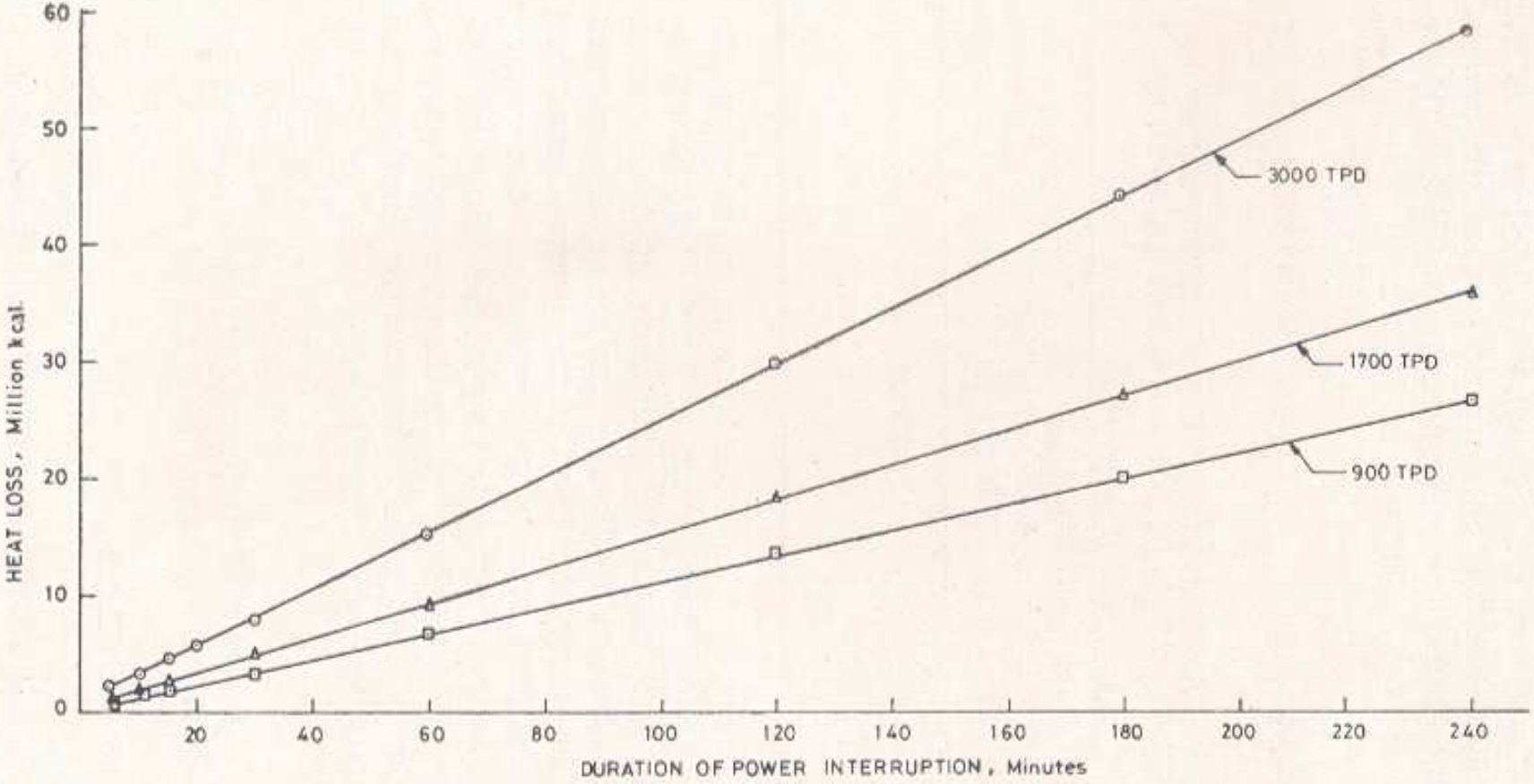

Fig. 4 Influence of Power Interruption Duration on Heat Loss

life. Each stoppage of kiln aggravates this effect. NCB's studies on a 2500 tpd dry process precalcinator kiln revealed that specific refractory consumption was higher in the year when the number of power interruptions was high (Table 1).

TABLE 1

SPECIFIC REFRACTORY CONSUMPTION VIS-A-VIS NUMBER OF POWER INTERRUPTIONS IN A 2500-TPD DRY PRECAL KILN

YEAR	NO OF POWER INTERRUPTIONS	SPECIFIC REFRACTORY CONSUMPTION KG/T OF CLINKER
1985	101	0·916
1986	28	0·713

Sudden stoppage of kiln affects the temperature profile of the kiln system. The clinker coating, clinker-brick interaction zone and the bricks, with their distinct physical and thermal expansion coefficients, are susceptible to such temperature fluctuations. Due to the uneven expansion and contraction behaviour of the bricks and the coating during the stoppages and restarting of the kiln, the coating peels off easily, resulting in the direct exposure of refractory bricks to the higher temperature, causing the refractory bricks to spall. All this cuts down the life of refractory in kiln.

It is further observed that thermal shocks cut down refractory lining life to the extent of one-third.

3.4. Poor Quality of Clinker

Each time a kiln stops, the material inside the kiln at

the time of stoppage is exposed to improper thermal conditions. This results in improper burning and hence inconsistent quality of clinker. The effect is more pronounced when the kiln is restarted after prolonged stoppage.

3.5 Reduced Life of Motors, Plant and Machinery

Poor quality of power, ie, voltage and frequency variations, adversely affects the operating characteristics of induction motors, eg, torque, starting and full-load current, slip, power factor, efficiency and temperature rise (Tables 2 and 3). The studies show that operation of motors at 10% lower voltage reduces their insulation life by 40%.

Power cuts and trippings too adversely affect the life of kiln shell, girth gear and pinion, bush bearings, switch

TABLE 2

EFFECT OF VOLTAGE VARIATION ON INDUCTION MOTOR CHARACTERISTICS

Characteristic	Voltage Level	
	110%	90%
Torque	+ 21%	— 19%
Starting current	+ 10–12%	— 10–12%
Full-load current	— 7%	+ 11%
Temperature	— 3–4°C	+ 6–7°C
Power factor	— 3 Points	+ 1 Point
Efficiency	+ 1 Point	— 2 Points

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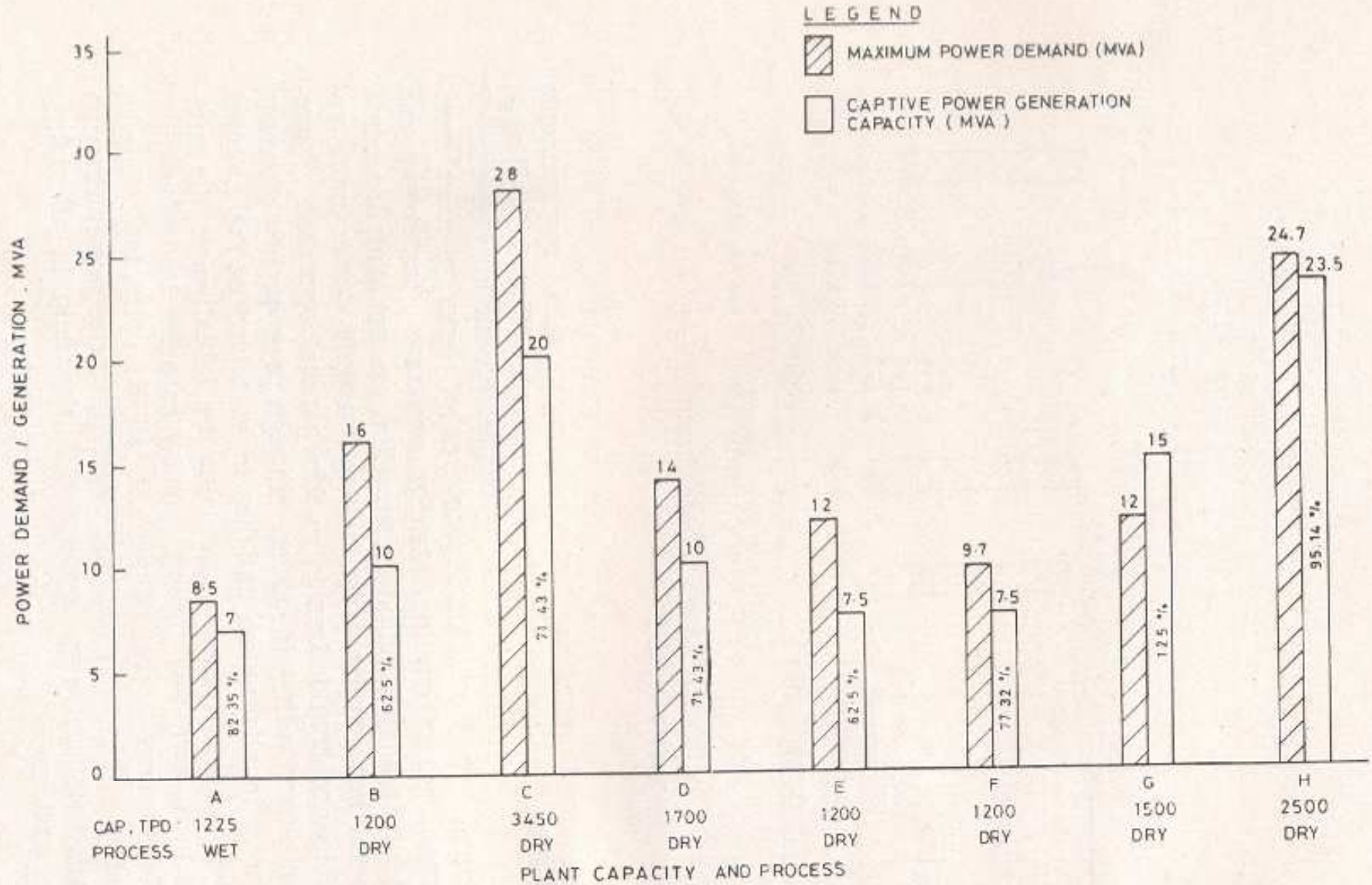

Fig. 6 Maximum Power Demand and Captive Power Generation Capacity


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