1.3 Bulk Oil Circuit Breaker (BOCB)

In this type of high voltage circuit breaker oil is used for arc quenching and as insulation between phase contacts and between earthed parts of the breaker case/tank and the contacts. The same mineral oil is used as transformer insulating oil.

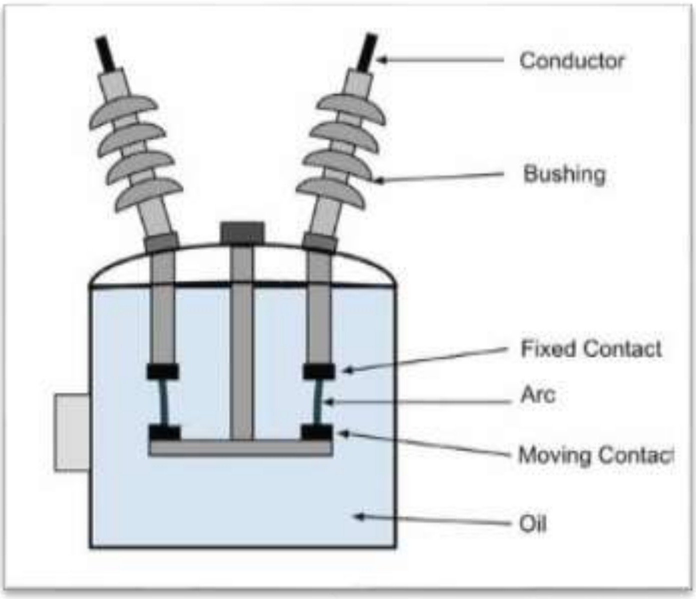

Figure 6: Inside a BOCB

Figure 7: 3 phase BOCB

The BOCB is suitable for voltages between 1-330kV. A BOCB was typically used by the power industry for high voltage (>52kV) applications. Mostly replaced now by SF6 based circuit breakers.

When the contacts are moved apart an arc flows between the fixed and movable contacts. The heat from the arc causes a hydrogen bubble to surround the arc. (The hydrogen comes from the oil which consists of hydro-carbons.) Hydrogen is excellent at extinguishing the arc. The arc should be extinguished at the zero crossing point of the alternating current/voltage, i.e. when the voltage and current are zero. When the voltage and current increase the gap should be sufficient to ensure the arc does not re-strike.

The disadvantages of BOCB is that oil is flammable, hydrogen (plus oxygen) is explosive. During arcing carbon contaminates the oil, reducing its dielectric strength. The oil tanks need to be large and the higher the voltage, the larger the tank required. This also requires substantial foundations to support the tanks.

1.4 Plain (Air) Break Circuit Breaker (ABCB)

This type of breaker works by first stretching the arc, then it is "chopped" into a number of smaller arc. By stretching the arc the dielectric of the air-gap is increased. The resistance increases and the arc becomes cooler. Once the dielectric is greater than the voltage across the electrodes, the arc is extinguished.

When the main contacts open (see Figure 8) an arc forms at the arc contact. This travels up the contacts increasing in length as it does so (see Figure 8A). When it reaches the splitter (see Figure 8B) it becomes a number of smaller arc.

The plain-break circuit breaker is suitable for voltages between 120V - 15 kV. The ABCB is used for low-voltage (<1,000V) power distribution switchgear.

When the line and neutral currents are balanced, the net magnetic fluxes is zero so no current is induced in the sensing coil. When the line and neutral currents are not balanced a flux is produce by the primary coil. A current is induced in the secondary winding which activates the tripping mechanism

4 Energy Tariffs (Task4)

4.1 Common Terminology

4.1.1 Maximum Demand

Maximum Demand is the highest peak of usage (kWh) in any given time period during a meter reading period. It is usually measured in kW (sometimes kVA). (It is usually measured over a period of half an hour.)

4.1.2 Load Factor

Load factor is the utilization rate (i.e. the efficiency of energy use). It is the ratio of total energy (KWh) used in the billing period divided by the possible total energy used within the period (i.e. running at maximum demand for the entire period).

It is the total electricity used (kWh) in a given billing period against maximum demand (kW) multiplied by the number of hours (h) in the billing period. For a given billing period the load factor is calculated as follows:

$$Load\ Factor = \frac{Total\ consumption}{Maximum\ demand * hours\ in\ period}$$

(It has no units.)

4.1.3 Diversity Factor

The diversity factor a ratio of the sum of individual maximum demands for all equipment against the maximum demand for the whole system. It is the demand placed by the currently running equipment divided by the maximum demand for the plant. It is the total installed load versus currently running load.

$$Diversity\ Factor = \frac{\sum Individual\ max.demand}{Plant\ max.demand}$$

(Diversity factor is always ≥ 1. It has no units.)

4.1.4 Demand Factor

The demand factor can be thought of as the instantaneous power consumption (i.e. power of everything that is currently turned on/running) versus the power consumption if everything was turned on.

$$Demand\ Factor = \frac{Average\ power}{Peak\ power} = \frac{\text{Maximum demand}}{\text{Total connected load}}$$

(Demand factor ≤ 1. It has no units.)

4.2 Two Part Energy Tariffs

Generation and transmission of electricity incurs two types of costs: capital expenditure and revenue expenditure.

Capital expenditure covers the one-off cost to build the plant and distribution network or work to extend the life or capacity of the plant. The electricity company generally borrows the money to cover capital costs, then pays it back over a period of time with interest.

$Change\ in\ demand\ charge$	$1{,}360.80 - 1{,}176.78 = £184.02\ pcm$

Table 11: Load factor calculation

$Assumptions:$	$The\ kilns\ are\ used\ during\ the$ $8\ hours\ per\ day, 23\ days\ per\ month$
$Avg\ Demand$	$Energy\ consummed\ in\ a\ period\ of\ time$ $divided\ by\ the\ period\ of\ time$
$Avg\ Demand$	$= \frac{4{,}480}{8 \times 23}$ $= 24.34782609$ $= 24.35\ kW\ (2d.p.)$
$Load\ Factor$	$LF = \frac{Avg\ Demand}{Max\ (Peak)\ Demand}$ $LF = \frac{24.35}{120.00} = \frac{14}{69}$ $LF = 0.20289855$ $LF = 0.20\ (2d.p.)$