**Role of Lubrication**.

A major loss of compaction. energy takes place became of friction which affects :

1. the density and-density distribution within the compact
2. the strength of the compact
3. the ease of ejection after pressing, and
4. the wear of the die

During compaction several types of friction occurs as follows.

(a) friction between moving punches and die wall which is relatively small and the pressure loss caused by the practically negligible

(b) friction between adjacent particle which is insignificant and plays a minor part in compaction

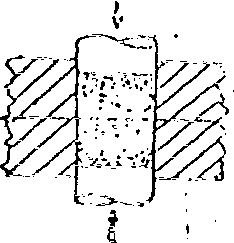
(c) Internal friction within the powder particles during deform

(d) friction between powder particles and the die wall, ( the one of the most important factors which after the uniformed density throughout the compacted part this is the primary source of pressure loss during pressure and the magnitude of effect is dependent upon powder material, particle size and the distribution, particle shape and surface condition and the inter particle pressure)and

(e) friction between the green compaction the die wall during ejection this type of friction depends upon the powder material, die finish and tolerance and the compaction pressure.

When a compact is obtained by pressing from one sid.0 only the greatest density exists in the top layer just below the movable

Punch and nearest the die wall. The density drops with the increase of disunite from the punch face. Thus the lowest density occurs in the bottom layer nearest the die wall density variation is also found in the horizontal plane due to the decreasing pressure loss away from the die wall arising from the frictional effect. The total effect of density distribution is shown in fig. 23,



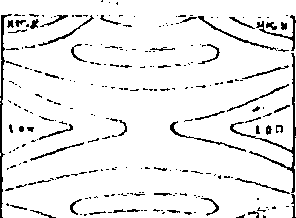


Fig. 24. Schematic illustration of basic green density distribution for double end die compaction.

It is evident that with increasing length: diameter ratio

Severe difficulties are experienced to density the lower end the of the Compact The better way to improve this situation is by insuring

pressing from both ends as well as limiting the length of the Compact When the length-to-diameter ratio becomes appreciable, high pressure and consequently high green density will be built up is the on both ends and the minimum density will be exhibited in the centre section of the compact (Fig. 24), Actual compaction way be relatively easy compared to the difficulties experienced during ejection of the green compact without its damage.

Another method of minimizing the loss of transmitted compacting pressure is to reduce the frictional effects thereby decreasing the density variation by the use of it die wall or powder lubricant As a result of work done on the die wall lubrication and the admixture of lubricant zith the powder, in has been well established that die lubrication is superior and more effective with regard to both densification and ejection 11. die wall lubrication is also beneficial to minimize punch travel and powder-fill depth. The other advantage of die wall lubrication is that it is not essential to dewax as a first step in the sintering operation. Also much less lubrication is required here to obtain the same effect when compared with the amount admixed lubricant. Thus, die wall lubrication causes lower production cost for both conventional P/M parts and P/M

Forgings11a. According to Marshall12. and Leopold and Nelson13, it  
has been observed that 0.012 mg/cm2 die-wall lubricant is more effective than 2% dmixed lubricant in lowering the ejection pressure.

The problem of die-wall lubrication is complex14 and it is mostly employed in the laboratory and in the manufacture of very large powder metal parts and P/M performs for forging. During the production by high speed pressing the application of die-wall lubrication becomes unsuitable.

Since production of components is made on a continuous basis, the normal practice is to blend powdered lubricants i.e., to include the lubricant in the powder max15. The admixing of solid lubricant into the powder prior to pressing appreciably reduces the pressure loss and hence density variation within the compact. More. over, it also causes less die wear. There are, however, some draw­backs in the-use of powder lubrication :

(1) In general, it decreases the How rate, (See Table 10) due to which difficulties are encountered in feeding and consistent die-filling

(2) A decrease in apparent, density occurs as tile amount or lubricant is increased front its critical con­centration. (See Table 10)

(3) It leads to high volume compression or large punch travel during compacting, if one does not stay below the critical concentration of the lubricant ; which results in high internal stresses contributing towards cracking of compacts during ejection. If the amount of lubricant is large, the overall strength is lowered owing to the formation of flint of lubricant (4) It results in higher initial material cost.

In the case of pressing of brittle material, e.g., carbides with a very high percentage of lubricant the strength of the compact may correspond to that of the lubricant. Moreover, lower­ing of green density may be expected at the higher lubrication level because of much lower density of lubricant, i.e large volume occupied by it compared with that of the compact. Thus, densi­fication is retarded with increasing; amount of lubricant from a cer­tain level.

The removal of lubricants is essential either during; or prior to sintering of the compacts, since they may adversely affect the mechanical properties if not completely "burned oil". In the latter case as in the manufacture or tungsten carbide, a separate production process is required which increases the costs. However, it is possible to recover the lubricant and use it again. In the reenter case it may present difficulties held cause even some definite harm to the components of the sintering furnace. In salve cases, particularly with reactive metals lubricants adversely affect the physical pro­perties of the sintered product.

It can be concluded that the advantages of lubricant far outweigh their disadvantages and its addition to powders is mostly made by the industry prior to die pressing.

**Properties** **of** **Pressing powder**

These are represented by the term compressibility and compatibility is one of the most important characteristics of a metal powder since it affects the densification process. If is a measure of the powders ability to deform under applied pressure and is represented by the pressure density ( or pressure / porosity) relationship. It is defined as the ratio of :-

a / the green density of the compact to the apparent density of the powder or

b/ of the height of the uncompact powder in the die to the height of the pressed compact or

c / of the volume of powder poured into the die to the volume of the pressed compact.

This ratio is usually termed compression ratio.

The maximum compression ratio is given by the relation.

Ultimate ( or true ) density of bulk material

Apparent density

Max . compression ratio =

Though the compression ratio can be varied from about 2 to 8, in most practical applications, it approaches a value of about 3.

Higher values of compression ratio require greater die depths and produce server compression due to the introduction of friction between the powder and the die walls and internal friction of the powder. Thus a low

compression ratio is preferred because of the reduction of :-

1-die depths.

2-breakage and wear of tooling and.

3-press movement and thereby it is possible to achieve higher production rate.

Both these terms are dependent on particle size, shape, porosity or density and hardness, surface properties chemical composition and previous history ( eg . hardening annealing treatment , etc) of the powder.