High Performance Mixes with New Lubricants

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***Abstract*—Higher density is required to obtain higher mechanical properties of PM components, in particular for the fatigue strength. Besides the compressibility of the base powder, the lubricant and compaction method plays an essential role for compaction of high density. The lubricant type and content are limiting factors to the compressibility due to their low theoretical density. However, by improving the efficiency of the lubricant, a lower added content of lubricant can be meet the requirement of during ejection and thus higher density can be achieved. In this paper, an increased density by using high performance lubricant in Fe-Cu-C mixes as well as excellent green strength and higher tensile strength after sintering, will be presented.**

Keywords – Lubricant; Lubrication; Green Strength; High Density;

I. INTRODUCTION

As the PM market and challenge from new application, high strength is always be required by PM technology to compete with other manufacture route. There are a number of ways used to improve the mechanical strength, including heat treatment, new alloy system and high density compaction method and so on. However high density is one of fundamental approaches to improve the mechanical strength of sintered components, in particular of the fatigue strength.

Besides the compressibility of the base powder, the type and content of lubricant plays an essential role for the compressibility. It has been demonstrated that efficient lubricants in combination with warm die compaction is a feasible process route for higher compressibility. Intralube® E and Intralube® HD are recently introduced lubricant that are used in PM press-ready mixes with super lubrication properties and high compressibility [1, 2]. In this paper, the performance of these two lubricants are benchmarked with Amide wax in Fe-Cu-C mixes.

II. EXPERIMENTAL

The first part of this paper presents an evaluation on ejection properties. A mix with composition ASC100.29+2%C+0.8%C+0.6%lubricant of different type (Amidewax, Intralube E and Intralube HD) was used in this lubrication testing. The ejection properties were measured according to Höganäs AB internal method. A ring with OD/ID 55/45 mm and the height with 15 mm was used for ejection properties measuring.

The second part presents compaction testing with less lubricant content. Due to more efficient lubrication of Intralube E and Intralube HD, the added content was less in this testing, shown in table 1. The compressibility, green strength and tensile strength were measured. The cylindrical specimens with diameter 25 mm were compacted to measure the green density according to ISO 3927:2011. The green strength was measured according to ISO3395. Tensile test bars according to ISO 2740 were compacted and sintered 1120℃, 30min in $90N_2/10H_2$. All testing bars for the measurement were compacted at 700MPa.

Table 1 ASC100.29+2%Cu+0.5%C+Lubricnat

Mark	Lubricant content	Die temperature
Lube HD	0.50%	90 ℃
Lube E	0.65%	70 ℃
Amide wax	0.80%	45 ℃

III. RESULTS AND DISCUSSION

In figure 1 ejection energy is plotted versus the compaction pressure. As can be seen, similar level of ejection energy was presented at 400MPa compaction pressure. But as compaction pressure increased, ejection energy of Intralube E and Intralube HD was not increased as much as Amidewax. When compacted at 800MPa, much lower ejection energy was presented at room

temperature compaction, compared to Amidewax. It is also indicated that the ejection energy was reduced significantly when compacted at warm die compaction, 26% reduced for Intralube E and 35% reduced for Intralube HD at 800MPa compaction pressure. The excellent lubrication and benefit at warm die compaction allows lower the lubricant content needed for ejection during compaction.

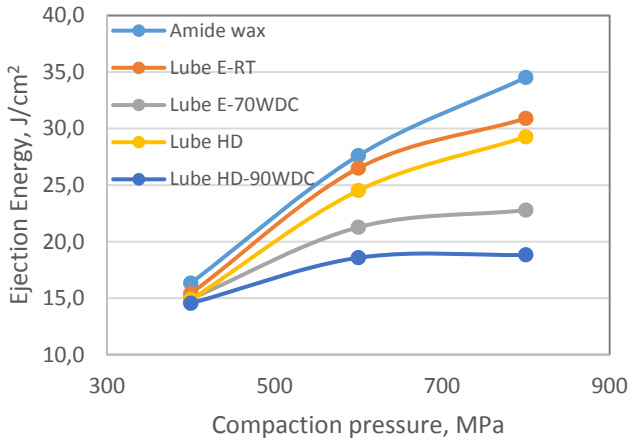


Fig.1. Ejection energy at different compaction pressure

The green density and green strength was presented in figure 2 and 3. It is obvious to indicate that much higher density was obtained from the mix with less content of lubricant, 0.17g/cm^3 for Intralube HD and 0.10 g/cm^3 for Intralube E compared to Amidewax, combining warm die compaction. Higher green strength was also obtained for Intralube HD mix, in which means good benefit in the green component handing and even green machining.

The tensile strength and elongation was presented in figure 4 and 5. Higher green density can result in higher tensile strength and higher elongation.

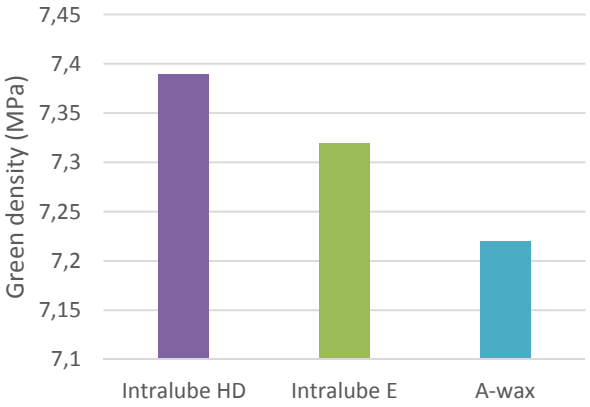


Fig. 2. Compacted density at 700MPa

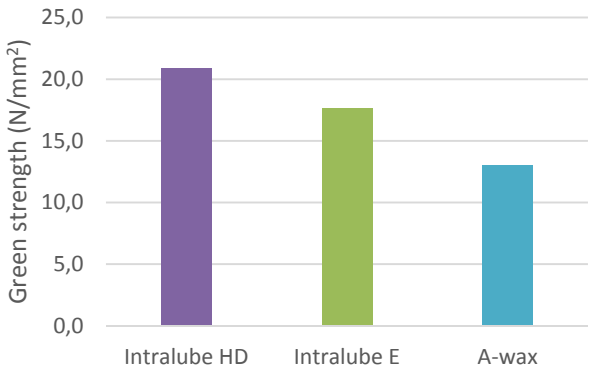


Fig.3. Green strength at 700Mpa

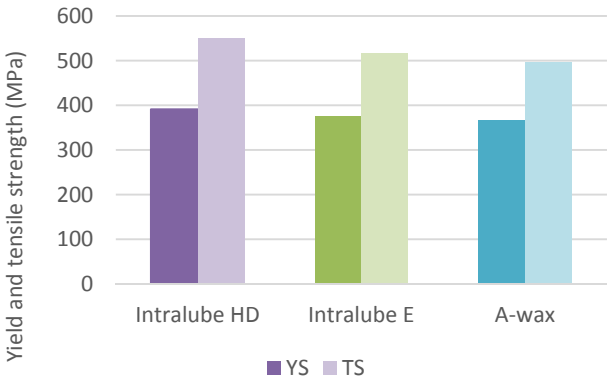


Fig.4. Yield and tensile strength after sintering

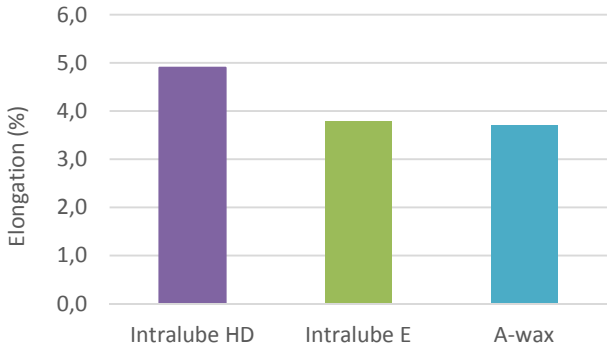


Fig.5. Elongation after sintering

IV. Conclusion

The both lubricant systems Intralube E and Intralube HD can enable compaction to high green density by decreasing the amount of lubricant added and heating compaction die, due to highly excellent lubrication properties and optimized to be used with heated die. However, the Intralube HD can even make higher density and higher green strength compared to Intralube E.

References

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