DIE LUBRICANTS FOR HOT FORGING

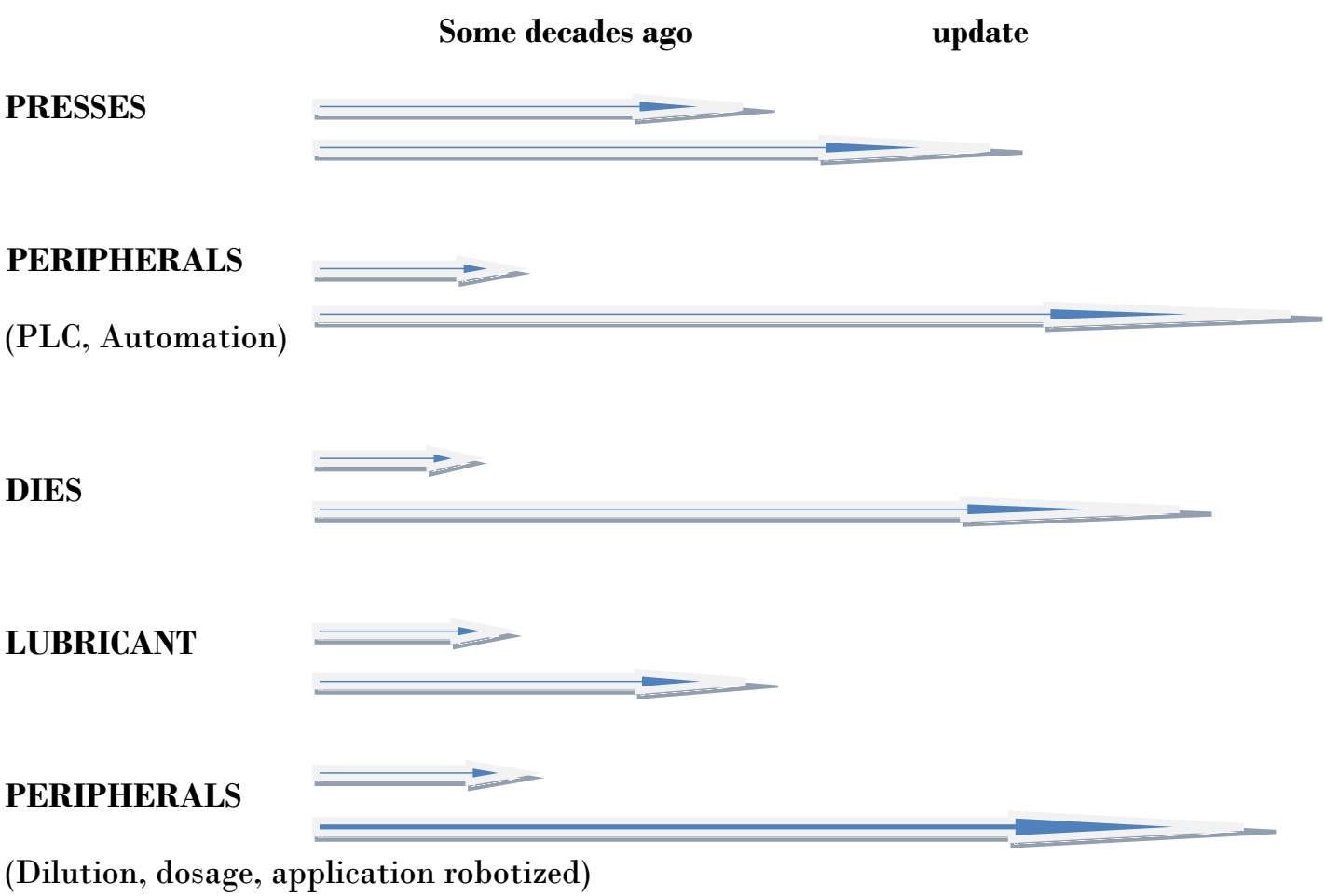
Author: Gustavo G. Schiuma

E mail: schiuma@forgelube.com

Perhaps does not exist in the forging industry any other subject of technical and also commercial nature more controversial than the related to the use of the so-called forging lubricants or die release agents. This has been in this way because the parameters affecting the lubricant are too many, interdependent one from the others and also because the technological development occurred in the hot forging process not always have been accompanied by parallel developments originated by the lubricants industry that despite the massive efforts on research and development has not been able to develop truly innovative products. Noticeably, on the other hand, stronger developments have been achieved in the preparation and application of the lubricants as well as in the press and die technologies. The real proof of this is that since at least the last 40 years the graphite-in-water lubricants that have dominated the market preference for the type of lubricant used by the forging industry have not been challenged seriously by any other type of products. Progress was evident, on the other side, on the technologies and control methods applied to the lube preparation, mixing and application techniques with the introduction of fully automated robots that are able to applied limited amounts of sprayable and atomized lubricants to the forging dies in full synchronism with the press functioning. The awareness of the described above has triggered in certain lube manufacturers the necessity to create "variations over the same topic" introducing doubtful and appellative product presentations of complicated demonstration on the field trials.

If it were possible to quantify the intensity and magnitude of the technological development occurred within the main referents of the hot forging process, we would have a table like this:

REFERENCIAL TECHNOLOGICAL DEVELOPMENT



In other words, the table above reveals that the relative importance of the die lubricant has "lost" relevance in the light of the significant technological progress occurred in the other referents of the hot forging process, among which are the design technology and steel alloys used in the manufacture of dies, that by incorporating novel design and computer simulations have been able to eliminate hotspots that in many circumstances were customarily attributed to the use and application of lubricants. The surface treatments of the dies, while contributing to the longer life of the dies also had the effect of reducing certain requirements requested to the lubricants. Other factors such as higher operating speeds, more intricate die designs, limited time available for the application of the lubricant, etc. have added pressure to the lube manufacturers for them to make products that meet these new requirements. While I can understand that the current situation is to attempt to remove importance to the matter of die lubrication (and this becomes very clear when the discussion points to the price issue) we have always to remember that without a suitable forging die lubricant our operation of forging parts simply paralyze and from that forgers can develop a more critical awareness and point of view of the importance that represents for the forging operation the forging lubricant.

I do not pretend to say that the research and development of new lubricants for dies has been paralyzed completely but that has remained restricted mostly to the scientific and academic arena that by duty of office seeks permanent solutions to the the tribological problems of reducing or eliminating the wear caused by friction between metallic parts in motion contact. The number of variables in the process of forging is very large and this makes that the selection of the lubricant to use has become a compromise in which the forger determines in advance which parameters wants to have under control and which are considered less important. For example a given forger may choose to prioritize surface finish and dimensional structure of the parts produced at the expense of lubricant consumption. Others may simply prioritize the issue of die life as the most important aspect to consider regardless the type of lubricant used. Others may prioritize the environmental aspects for the selection of the product to use, sacrificing in some instances, a greater durability of the dies. Some countries also may impose certain regulations and limits for the use of certain ingredients contained in the lube formulations.

Some lubricant manufacturers try to differentiate their products mentioning in their Data Sheets a myriad of features such as wetting point, type and characteristics of the graphite used.etc. Although is convenient and desirable to understand such details as well the physical and chemical characteristics of the products, what is really important to understand is that forgers do not buy lubricants or die release agents by its chemical formulae but **essentially** because of their performance during the process of forging. There are three primary types of lubricants for forging dies used today. These types can be classified as follows:

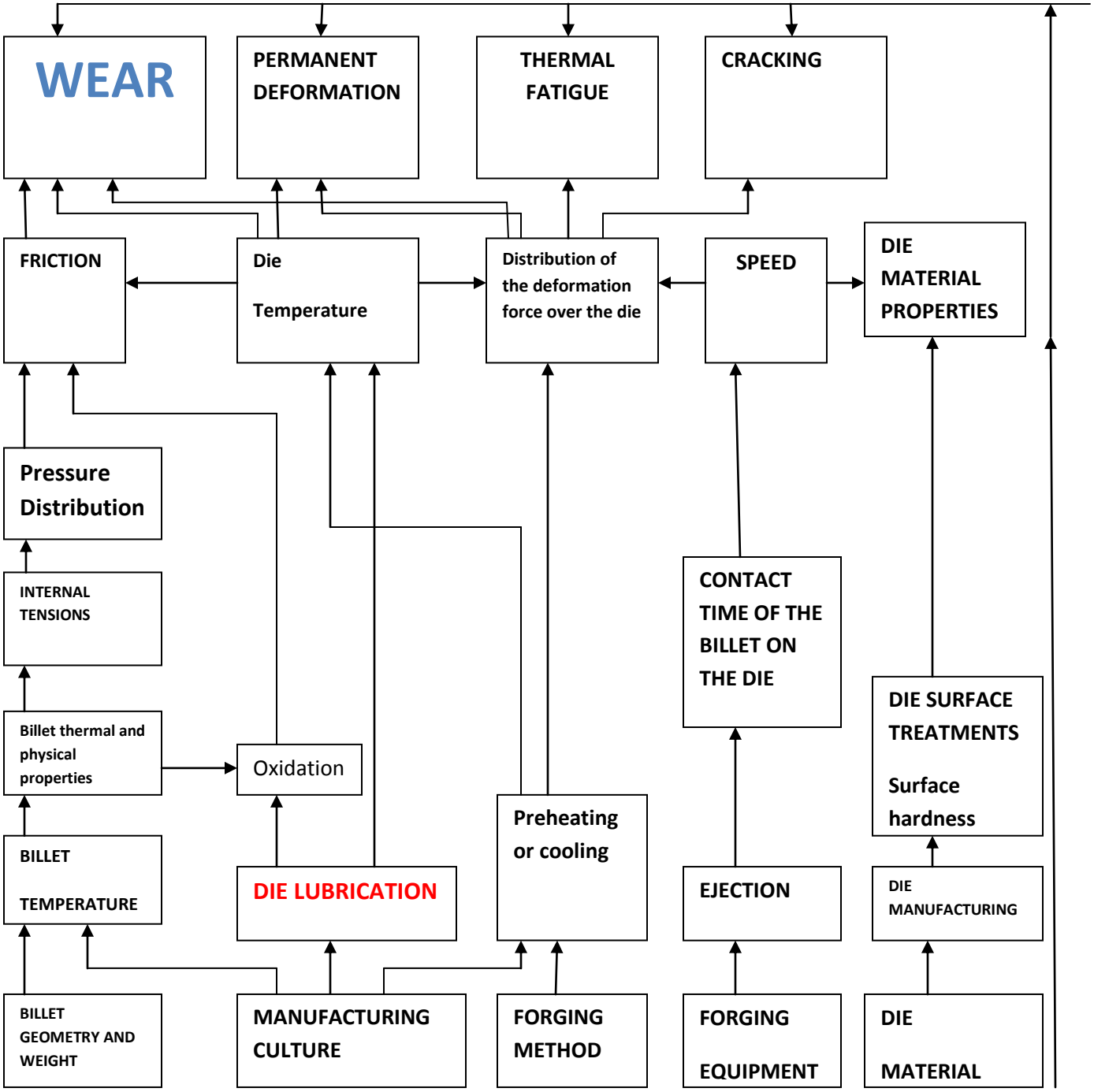
- **Graphite containing lubricants** (water-based, oil based, greases, etc). It is the main category having graphite as the primary active solid lubricant in function of their proven ability to promote the functions required for a forging lubricant which summarizing are : a) **Lubricate** – thus, allowing an even and smooth flow of the work piece to obtain a perfect filling of the die contour; b) **Release** – assist for an easy removal of the work piece from the die (without damage to it); c) **Cooling** – thus, allowing heat removal of the die in a controlled way diminishing thermal cracking occurrences and die wear, and d) **Protection** – preserving the die integrity as much as possible in order to run economic and extended productive series of forging parts.

- **Synthetic lubricants –** It is a category of products based on salts that do not incorporate or use graphite as their main ingredient in their formulations. This category of forging lubes have operational limitations in relation to graphite although some forgers (approximate 15% of the world total) have found that for their forgings results obtained are equal to the results given by graphite products. Such type of products has performed well in the forging of flat and not complex forgings were extrusion like flow metal occurs. A major issue for their selection is the consensus of the industry that they are clean and environmentally superior to products containing graphite.

- **Lubricants containing molybdenum disulphide, boron nitride, glass and other ingredients.** They are mainly used to forged titanium parts and other special alloys used in aerospace, defense and nuclear power

Solved the problem presented by the initial choice of the category of forging lubricants to use, the selection of which one to use amongst the so many offered by the lube suppliers becomes a real challenge as to proceed according to standardized modern industrial management schemes is still a non unanimous issue, varying from company to company the scheme and therefore the outcome. In other words, the selection of the specific brand product to use will depend on how are structured and organized the engineering, quality control, die manufacturing and design, production and purchase departments and how their input and information generation is put to interact with the external information given and supplied by the different suppliers of die forging lubricants. This large collection of data must be placed at the disposal of those commissioned for the search of economies that new products / applications can offer. This exercise requires the creation of collective and pro active work to gather evidences to support and facilitate the execution of the measures deemed necessaries as to test new die lubricants under conditions of "normality". The tabulation of data is extremely important as well as the proper and correct evaluation of such data and its real meaning from the technical and economic point of view. We have often encountered situations in which the evaluation methodology such as the used to determine die life, lubricant consumption, and measurement of billet and die temperature is performed following procedures that differ from measurement to measurement, thus making results somewhat unrepresentative due to their erratic and non systematic procedure for gathering such information. In other words, unless **all** the parameters be duly identified in advance and also after the field tests; measurements and checks be conducted through hierarchy plant personnel and in full coordination with the representatives of the lube manufactures, the results may be satisfactory or not, but certainly will be reliable and will aggregate value to the ongoing process of identification of the difficulties and problems associated to the process of die lubrication and their impact on the cost and quality of the forged parts.

The graph below illustrates the number of variables and their inter-relationship with the lubrication and wear of the dies.



Finally, we always have to remember that the objective of the quality forger is to produce as many pieces are achievable by the capacity and capabilities of the equipments allotted to the forging manufacture at the lower possible cost prioritizing this aspect over others as die life and consumption of lubricants. The marketable products from the forging industries are rough or machined forged pieces and sometimes entire components and therefore rely on such products and in their cost of production much of the success and future of the forging industry. Forging is becoming rapidly an interconnected and competitive global industry and in process of fast geographic volatility because of the competition coming from different regions of the world with technology, skilled labor, availability of raw materials and internal and foreign markets consumers with necessity of massive forging manufacture. These countries, where India and China come in first place and Brazil and Mexico in second are the most active in the "push" for market share and expansion.

The same market pressures and challenges can be applied to the forging lubricant industry which in a way depends on the forging industry dynamism for their continuous expansion on their search of new lubricants and application systems. This situation, however, has often been misinterpreted and not followed in the daily practice related to the use and application of Forging Lubricants. We have observed many times dilute lubricants with contaminated or inappropriate water having high mineral content, using as lubricants in home products made by simple mixing different ingredients such as wasted industrial oils, graphite, greases, etc. Also we have seen using application technology such as the use of robots with subsequent hand application. This situation reflects to some extent the relative lack of attention the forging industry is devoting to the matter of die lubrication. Quality and free from defects forgings such as surface cracks, internal oxide filling, lack of reduction and use of dies below their maximum potential will only be an achievable target if the culture prevailing within the forging industry recognize the importance of forging lubrication and works towards the implementation of standardized methods for the evaluation, selection and practical control of the lubricants once in use and also during its experimental trial phase. This culture must be the result of a joint work of the forging industry with the developers and manufacturers of Forging Lubricants.

As a final remark I would like to mention a statement that I use to comment with the personnel of the forging industry involved in matters of die lubrication: does not matter how good the lubricant is if not properly applied to the die surface, in the form, angle, pressure, distance and atomization proper for the specific die –it will not impart the expected performance-

This article aims to help create awareness for the die lubrication issue in the hot forging industry.

Gustavo G. Schiuma the author is Director of FORGELUBE SRL de CV. for additional information, please contact Gustavo G. Schiuma at the telephone 52-81-8372-1358 or by mail to: schiuma @ forgelube.com