

# Potentials and Issues in Manufacturing Water-based Graphite Dispersions (-lubricants) in Sri Lanka as Value Added End Product of Natural Graphite

Ekanayake E.M.K.B

Geological Survey & Mines Bureau, Badulla Regional office, Sri Lanka

\*Corresponding author – kapilabe1972@gmail.com

## Abstract

Sri Lanka is the only country in the world known to extract and produce commercially viable quantities of natural crystalline vein graphite. Currently Bogala Graphite mines and Kahatagaha Graphite mines are famous underground mines and largest natural graphite producers which supply natural vein graphite in the form of various product categories to international graphite market. It is said to be raw graphite or Run-of-mine (ROM) taken from underground mine is subjected to certain value adding steps such as separation into carbon grades and milling and grinding to requested particle size before export. But still value addition of graphite is a hot topic in many technical forums as well as among politicians and civil society. As we know, graphite is a miracle material in the industrial world as it involves or becomes an invaluable material in many industrial products as well as applications. So, among many graphite applications or end products, water-based graphite dispersion (lubricant) which is known as hot forging lubricant is one typical value-added graphite end product which can be produced in Sri Lanka using its own raw material. On the other hand, even though hot forging industry is not available in Sri Lanka, we can focus on our neighboring countries in South Asia specially India and Pakistan where world largest forging factories located and manufactured almost all forged parts for global automotive industry.

This paper discusses potentials and issues related to manufacturing water-based graphite dispersions (lubricants) in Sri Lanka. This is one value added graphite end product and formulated specially aiming hot forging industry.

**Keywords:** coating, forging, lubricity, powder pre-mix, solid content,

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## 1. Introduction

Natural graphite is known to be much needed industrial mineral in fast developing new technological applications in the world and as we know it is mainly used in refractories, batteries, steelmaking, expanded graphite, brake pads, casting surfaces

and lubricants. Water based graphite dispersions or lubricants is graphite-based end product which is specially used in forging industry. Forging is a process involving plastically deforming an alloy at a temperature above its recrystallization point. Figure.1 shows a forging part (an automotive part) at its recrystallization stage [4].

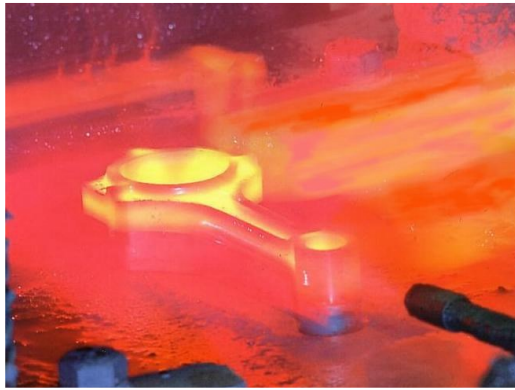


Fig.1 A forging part at its recrystallization stage

Today, many forged parts are used in automotive industry such as crank shafts, axles, pinions, arms etc. Fig. 2 shows some forged parts manufactured for automotive industry [1].



Fig. 2 Some forged parts for automotive industry

In forging, diluted water-based graphite dispersions is applied on forging dies as a coating to acquire many benefits as mentioned below [4].

- Outstanding lubricating properties
- Excellent release properties
- Uniform wetting of hot dies
- High stability
- No build up in die cavity
- Extended die life
- Non flammable
- Causes no issues in waste water

The dilution ratio varies according to the metal parts to be forged and generally the dilution ratio is ranging from 1: 10 to 1:40. To produce graphite dispersions, very

finely ground graphite particles are dispersed in a liquid. This liquid is often normal water. Dispersions with fine-grained graphite improve forging operations and are used in the warm and hot forging process, while coarser-grained graphite dispersions withstand the high temperatures created by the lubrication of mandrel bars and rollers [3]. They also serve as separating agents in the casting and moulding of metals.

Fig. 3 shows the final appearance of water-based graphite dispersion (lubricant)

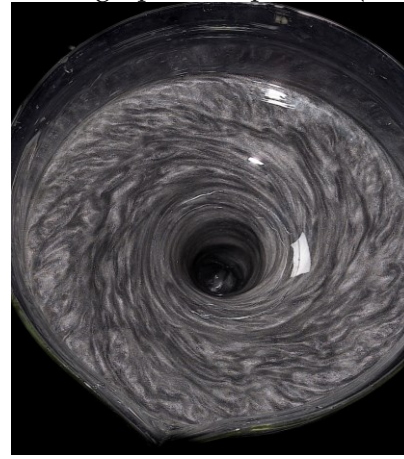


Fig. 3 Water based graphite lubricant

Quality control involves below parameters measured in graphite dispersions [2]. These parameters are very significant in achieving quality end product and minimize defective forged parts.

1. Solid content measurement
2. Viscosity measurement
3. pH value measurement
4. Particle size analysis by Laser diffraction

When manufacturing graphite dispersions (lubricants), above parameters should be monitored in batch wise and samples of delivered products should be kept at least 1 year period. That will be useful in any query after the delivery for any quality issues.

## 2. Literature Survey

Water based Graphite dispersions are widely used in many hot forging applications due to specific characteristics of graphite in metal forming in forging industry, friction is controlled by a suitable lubricant where nowadays graphite dispersions are widely selected due to many reasons. The dispersion is expected to have certain characteristics and to perform some, if not most, of the following significant functions [1].

- Reduce the sliding friction between the dies and the workpiece. This is achieved by using water-based graphite dispersion of high lubricity.
- Act as parting or releasing agent and prevent sticking of the workpiece to the dies.
- Possess good insulating properties specially in hot forging to reduce heat losses from the workpiece to the dies.
- Possess inertness to prevent or minimize reactions that will degrade the dies and the workpiece material at the forging temperatures used
- Be non-abrasive to reduce erosion of the die surface and die wear.
- Be free of polluting and poisonous components and not produce unpleasant or dangerous gases.
- Be easily applicable to and removable from dies and workpiece.
- Be commercially available at reasonable cost.

## 3. Methodology of manufacturing of graphite dispersions and its quality control

Water-based graphite dispersions is a mixture of finely milled graphite powder (-less than 5 microns in size) and normal water with few chemicals such as biocide, cellulose & surfactants added in to get some properties while using as hot forging

lubricant(dispersion). Once the natural graphite is converted into less than 5-micron size particles, such graphite becomes a status of colloidal graphite when dilute with water so that sedimentation never takes place. Sri Lankan graphite is having superior performances in using as graphite lubricant in hot forging as it has inherent properties such as high lubricity, standing in high temperature and chemically inert etc.

Mixing of pre-mix graphite powder with water can be done using mixing plant specially designed for preparing aqueous solutions in chemical industry. The output coming as graphite dispersion (-lubricant) can be filled into metal drums (220 litres in capacity) or Intermediate Bulk Containers (IBC) which are 1000 litres in capacity. The formulation of graphite dispersions may vary as per the applications of different forged parts such as crank shafts, axles, gear wheels & rods etc. so that variation of chemical composition can be addressed as well. Anyhow, in general the composition of graphite dispersion is consisted roughly 25% solid content of graphite powder with certain chemicals such as biocides, cellulose and surfactants with 75% of water.

### 3.1 Identified issues

Some issues could be identified related to manufacturing water-based graphite dispersions in Sri Lanka using its own natural graphite which can be mined out from Sri Lankan underground mines.

- Need to have a jet mill facility which is one huge capital expenditure. Jet mill is used to convert normal graphite powder into very fine micron sized powder. Unless the suitable graphite material should be sent to make powder-mix in another country where jet mill facilities are available and import back to Sri Lanka.
- Technical know-how specially chemistry of graphite pre-mix powder which consisted of biocides, cellulose, surfactants, and

some other chemical ingredients involved. Currently, such know-how is lacking in Sri Lanka.

- Huge cost for imported packaging material such as metal drums and Intermediate Bulk Containers (IBC) specially designed for liquid transportation.
- Procurement of special industrial chemicals which essentially required for mixing with pre-mix as well as with dispersion during mixing stage. All such industrial chemicals should be imported and getting approval for import from respective government authority is highly time consuming as well as cumbersome procedure.
- Maintaining humid-free properly ventilated warehouse for storing pre-mixes. It would be an issue if the dispersion plant is in wet zone of Sri Lanka
- Logistically it would be an issue if the dispersion plant is located far away from the seaport which is used for exporting the finished product. The transportation cost of imported packaging material from the seaport and finished dispersion material transportation to the seaport should be taken into consideration when the particular plant location is selected.
- Finding suitable and uninterrupted water source and required quantity which would become the major component of the dispersion product. If the water quality is not suitable or make some issues in degrading the quality of the dispersion, the water should be used after subjected to Reverse Osmosis (RO) operation
- Maximum shelf life of the product would be one year so that the product must be prepared based on the order placed by the client.

### **3.2 Potentials within Sri Lanka for water-based graphite dispersions as value added graphite end product.**

Currently, there are two major underground graphite mines in Sri Lanka and the graphite mined out from these mines is very high purity in quality. Thus, procuring of such graphite for any prospective investor intended to manufacture water-based graphite dispersions is much easier as the prime raw material for that particular graphite end product is available within the country, some other potentials and supporting matters for manufacturing graphite dispersions are mentioned below.

- As most Sri Lankan underground graphite mines are having excessive amount of underground pure water, same water can be used for dispersion formulation without any additional cost for water compared to municipal water or any outside supplying water which is now expensive.
- As there is huge market for forging lubricants in south Asian countries specially in India and Pakistan, supply of dispersions is logistically much easier via sea freight from Sri Lanka.
- Tax concessions (-mostly zero tax) can be taken for certain packaging material especially metal drums and IBCs under the Temporary Import for Export Processing (TIEP) scheme introduced by Sri Lanka Customs.
- During winter season in Europe, forging lubricants manufactured in European countries are not manufactured and exported to Asian market due to freezing of lubricants so that it is a good opportunity to supply the graphite dispersions (-forging lubricants) to such market from Sri Lanka.
- Less time taken for sea freight from Sri Lanka to South Asian countries

where hot forging lubricant market is available

#### 4. Discussion

Manufacturing of water-based graphite dispersions in Sri Lanka is one lucrative export business as Sri Lanka is producing world's highest purity natural graphite which is well suited for manufacturing graphite dispersions. Lubricants made from Sri Lankan natural graphite has already shown superior performances during forging trials done in India and Pakistan. Now, manufacturing of this graphite end product has already begun in commercial basis in Sri Lanka and can be further expanded by new business entities who can invest on this particular area. As an export business, this industry is having remarkable potentials in Sri Lanka due to very particular reasons discussed in this paper. Even though there are a few issues to overcome in executing the manufacturing process in Sri Lanka, that can be managed with technical support from outside expertise at the beginning and government support for any import issues related to special chemicals required for lubricant formulation.

#### 5. Conclusions

Manufacturing of water-based graphite dispersions is highly profitable export business as well as can earn substantial foreign revenue to Sri Lanka since world's largest forging factories located in South-Asian region specially in India which acquires the highest share of providing forged automotive parts to world's largest automakers all over the world. In addition, this is a real value addition of our natural graphite mined in Sri Lanka which can become a monopoly business as none of any other country in the world is having

natural crystalline vein graphite to mine in commercial basis and manufacture this kind of industrial demanding graphite end product.

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