

## Technical Information Document

### Cylinder Liners – Material and Its Influence on Quality

#### I. *Function*

Before we can understand what factors contribute to manufacturing a high quality cylinder liner, we must first consider the function of this product. Basically, it functions as a wear part i.e. it is designed to wear in a controlled manner to protect more expensive parts like pistons and engine block from wearing. Additionally it provides a surface against which piston rings can slide with minimum possible friction and maximum sealing, to prevent combustion gases from escaping into the crankcase or lubricating oil from entering the combustion chamber. Also, it conducts the heat generated due to combustion, away from the combustion chamber and into the coolant. Finally, it functions like a guide for the movement of the piston.

#### II. *Properties*

As explained above, the cylinder liner has to satisfy a variety of requirements, which sometimes conflict with each other, hence it must be designed and manufactured within strict technical parameters. The material, dimensions and geometry of the cylinder liners have to be controlled within exacting specifications that have been established by the automotive industry over the past decades.

**AutoGRACE**<sup>®</sup> cylinder liners are manufactured as per ISO quality norms which require constant monitoring of the manufacturing process to satisfy strict technical specifications. All our cylinder liners are manufactured by **induction melting** and **centrifugal casting**, which are the most modern foundry processes used in manufacture of cylinder liners.

#### III. *Material*

Producing the correct grade of cast iron is the first and the most important step in controlling the quality of a cylinder liner. There are three important factors in the material of any cylinder liner:

##### 1. Hardness

Proper hardness is mandatory for wear resistance. For most automotive applications the appropriate hardness range is 180-220 BHN. Hardness less than 180 BHN will cause the liner to wear prematurely, but also more than 220 BHN will cause premature wear of the piston rings, since rings are designed to function with liners of a particular hardness. **Sometimes, users relate higher hardness with better quality, however, this is a common misconception.** Cylinder liner should wear in a controlled manner hence it must not be too hard, or too soft.

**AutoGRACE**<sup>®</sup> cylinder liners have just the right hardness, neither too high nor too low. For every production lot, we test the hardness using in-house hardness tester. **Excessive hardness** not only causes premature wear of piston rings and pistons, but **also decreases machinability of the liner, causing excessive wear of tools** used to hone the inner diameter of the liner in the workshop.

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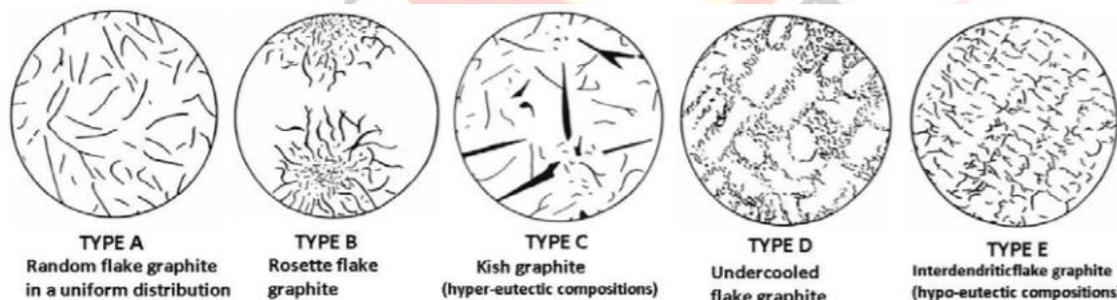
### 2. Chemical Composition

This refers to the percentages of various elements like Carbon, Phosphorous, Silicon, Manganese, Chromium etc. in the material of the liner. The correct composition will give cylinder liner wear resistance, good machinability, strength and lubricating properties, all desirable characteristics in a cylinder liner.

**AutoGRACE**<sup>®</sup> cylinder liners are manufactured in a modern facility with in-house laboratory. We have the **SpectroMAXX brand spectrometer from Germany** to test the chemical composition of each production lot manufactured by us.

### 3. Microstructure

Microstructure is the least understood, and the most important, aspect in the material of a liner. It refers to the size and distribution of graphite flakes in iron. The manufacturing process transforms carbon added during the melting phase into flakes of graphite, which is a form of carbon. When the cylinder liner wears, these graphite flakes, along with the engine oil, minimize the friction between piston rings and the cylinder liner.



**AutoGRACE**<sup>®</sup> cylinder liner material contains **maximum Type A** distribution which is the most desirable type of graphite distribution. No presence of type C, D and E distribution is tolerated in the high-quality **AutoGRACE**<sup>®</sup> brand cylinder liners. **Size of graphite flakes** is also controlled precisely since flakes that are too large or too small cause deterioration in the strength and wear properties of the material. **Highly accurate microscopes** are used to test microstructure of the material used to manufacture our liners.

### IV. Dimensional and Geometrical Accuracy

Although this technical paper focused on material of the cylinder liner, dimensional and geometrical accuracy of the cylinder liner are equally important.

**AutoGRACE**<sup>®</sup> cylinder liners are machined using modern CNC machining centers, honing centers and centerless grinding machines. Hence they comply with very strict tolerances and geometrical parameters such as ovality, concentricity and taper.