5. PERFORMANCE AND ADVANTAGES

a. Benefits

The benefits to the cermet A, B & X coating process are gains in Power/Friction/Sealing as well as gains in Wear resistance/Durability and Corrosion resistance.

Performance gains are achieved through a reduction in the friction between the apex seals and the trochoid surface. The friction is reduced due to several factors including and not limited to the olephelic nature of the cermet coatings (meaning the coatings attract oil, retain oil and in the case of cermet A & X has self lubricating properties), the superior finishing process that we use on our housings and our proprietary sin-wave patter that we induce into the finish. Power gains using our cermet A, B & X coatings on the rotor housings alone are in the 2.5-5% range over chrome housings. When using our coatings on the end and intermediate plates additional gains of 2.5-6% can be realized.

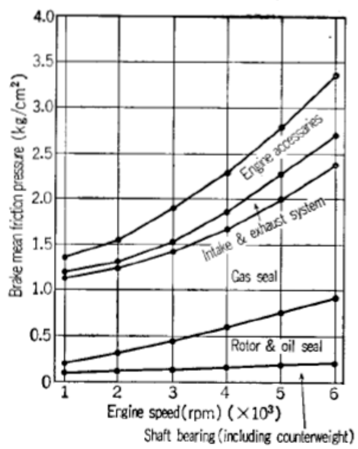

Fig. 4.2 Analysis of friction loss

In a rotary engine, around 25% of the losses are due to friction. By reducing seal friction between the seals and the rotor housing and the end housings we can reduce the losses and achieve a performance gain measured in horsepower and torque. See diagram to left to see how the various components cause power losses.

The extremely high micro-hardness of coatings as well as the olephelic nature of the coatings also dramatically increases the wear resistance of the rotor housings as well as its resistance to chatter marks and grooving. We have also found our coatings to be more resistant and robust to failure caused by rotor to housing contact and apex seal chipping and damage caused by foreign debris.

> *In one test we actually let a running motor ingest ½ cup of ground aluminum oxide grinding wheel with particle sizes up to 3mm. The rotor housings were untouched whereas the apex/side and oil seals and side plates had severe damage and wear caused by the highly abrasive material.*

In addition, the very dense (99.5% density) cermet material has a far greater corrosion resistance than pinpoint porous channel chrome as there is no exposed steel liner via any channels or pits with the cermet coating that may promote corrosion and flaking.

Cermet coated rotor housings have superior sealing ability and are also not subject to the same degradation of sealing ability over time as seen in the Chrome plated Mazda housings.

Over time, the Mazda chrome will experience wear. In the intake portion of the trochoid this is often manifested as chatter. In the vicinity of the trailing and leading plug there is also a large amount of uneven wear and distortion, seen as grooves and scratches. The cause of the wear by the spark plugs is thermal distortion of the rotor housing.

ALL used Mazda chrome rotor housings have a worn surface that greatly compromises sealing ability and performance. These effects are not always clearly shown with a compression test.

Dealing with the affects of thermal distortion in this area of the rotor housing has been very difficult for Mazda. Due to the high thermal loads and the asymmetric distribution of these thermal loads the trochoid wall tends to expand at different rates. These differences in thermal expansion cause the trochoid surface to warp during operation. The warped and deformed chrome plated trochoid surface does not form a good seal against the apex seal and thus allows unacceptable amounts of blow-by.

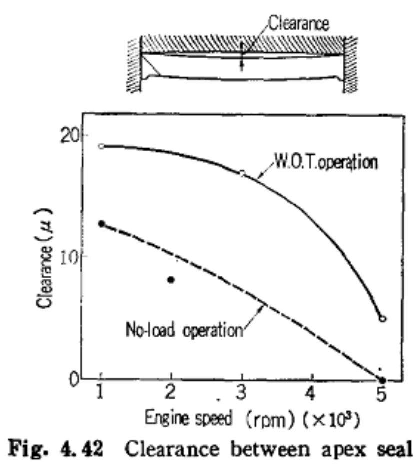

Fig. 4.42 Clearance between apex seal and rotor housing

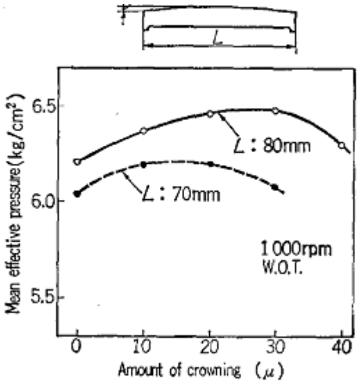

Fig. 4.43 Effect of crowning

To combat this issue Mazda has taken two approaches: the first is to compensate for the deformation by altering the apex seal geometry. The second is to alter the trochoid wall thickness in the vicinity of the spark plugs to aid in heat transfer.

Since 1985, Mazda has tried to manufacture an apex seal that will yield superior sealing at high loads. Several alterations have been made to the apex seal design to aid its sealing function. One alteration in particular was made to compensate for the thermal distortion of the trochoid surface. This alteration is the crowning of the apex seal along its beam. This slight crowning effectively compensates for the distortion of the rotor housings and provides a better seal… That is until the apex seal wears away the crowning effect.

The second method used by Mazda to compensate for the uneven thermal loads and expansion of the trochoid walls was to remove material in select areas of the trochoid wall to accelerate heat transfer around the spark plugs and reduce thermal distortion. These methods can be seen clearly on the renisis rotor housings and the earlier FD RX-7 rotor housings. Similar techniques have long been used by racers, such as the grinding of small channels in the vicinity of the spark plugs to aid with cooling efficiencies. The effectiveness of these methods is poor and there is room for further improvements in this area.

The cermet coated housings attack the root cause of this problem and have shown to alleviate the distortion problems of the trochoid surface through greater heat dissipation and lesser heat generation by friction. In addition to this, the honing method used by JHB applies a “reverse crown” on the trochoid surface ONLY in the areas greatly affected by this problem. This way the engine does not suffer the same problems associated with blow-by along the entire trochoid surface (around the entire rotor housing) when using a crowned apex seal. This honing method coupled with a true flat apex seal (such as a ceramic apex seal) have shown superior sealing ability and greater power yields than a chrome housing with a crowned apex seal.

In a head to head comparison, cermet coated parts are superior in every aspect and deliver greater power without any comprise of durability.

b) Housing comparisons

Models of housings and differences.

There are many differences between different model years of rotor housings ranging from the casting design itself to the porting and plug timing as well as the grade and quality of the materials used. The chrome plating has evolved over the last 35 years of rotary engine production and the underlying steel liner has also been upgraded accordingly.

The most visible difference is the exhaust port timing; the port timing and location have changed considerably from generation to generation.

The spark plug location and timing has also changed slightly between different years of rotor housings. The change was made for the S4 (1986-1988) model rotor housings that have different plug locations that the rest of the model years. The locations of the plugs on the S4 rotor housings match that of the Mazda Factory Racing Peripheral Port rotor housing.

The trochoid profile has also changed a very slight amount from generation to generation; these changes were seen in conjunction with a change of apex seal design, i.e. a change from 6mm to 3mm and from 3mm to 2mm and again from 2mm to shorter height 2mm Renisis. These changes are very minimal and intended to provide a better match between the apex seal radius and the trochoid surface.

There have also been some slight alterations in the casting moulds from generation to generation. Most of these are attempts at reducing the thermal distortion of the rotor housing in efforts to provide a better seal at operating temperatures. Other modifications have been made to make the rotor housing stronger in high stress areas that may have been prone to failure.

However, most of the differences in the molds have no functional value at all and are just the result of the rotor housings being manufactured at different foundries.

For racing we feel the best rotor housing to start with is the 1984-1985 13B rotor housing. This rotor housing has a trochoid profile that matches 3mm apex seal tip radius. It has greater water jacket volume, the water jacket o-rings are in the rotor housing rather than the cast iron plates (more reliable). The oil injection holes are larger and the spark plug positioning matches the latest generation rotor housings. Also, the exhaust port is slightly smaller and narrower than the later models allowing greater flexibility in exhaust porting. This rotor housing lends itself very well to the most common racing modifications such as turbulence grooving in the water passages, peripheral porting, doweling, addition of a far trailing plug hole and a floating combustion wall.

Another rotor housings that are excellent for modifying are the S4 naturally aspirated rotor housings. We use these as a base for our Peripheral Port rotor housings as the have the same spark plug placement as the Mazda Factory Racing peripheral port race housings.