Have you ever driven a car with a wheel out of balance? The faster you drive the more you notice the vibrations that come through the steering wheel. The vibrations not only affect your driving comfort, but over time will translate into wear in your car’s steering and suspension. As well as the cost of replacing worn parts, these are both systems that closely affect your safety and need to be in top condition.

Small cause – big effect

The effects of imbalance in your car wheel should be relatively small and easily detected. But since the forces and vibrations created by an imbalance increase with rotational speed, and mid sized ABB turbochargers rotate at up to 30,000 rpm (compared to about 800 for a car wheel at 130 kph/80 mph), we can see that accurate balancing of your turbocharger rotor is proportionately more crucial.

In fact, in a turbocharger even just a small deviation in the distribution of the mass around the rotor creates significant forces. The TPL 67-C is a medium sized turbocharger. In normal operation the rotational speed of the rotor is about 26,000 revolutions per minute. If you removed only 10 g of material from one blade tip, the imbalance created will cause a centrifugal force of 13,700 N. This is equivalent to a weight of 1400 kg – or a medium sized car! The mass of the bladed shaft, in comparison, is just 31 kg.

For these reasons rotor balancing has high priority during the turbocharger manufacturing process. Before delivery every rotor is balanced within very stringent limits. First, only the turbine shaft is balanced. Later, the complete rotor assembly with compressor wheel attached is balanced again. A balancing report is issued and stored as a reference in our database, along with the serial number of the turbocharger.

Factory balancing – the best start in life

The balancing process itself is a skill that requires not only know-how but a lot of experience as well. Nowadays, the balancing machine readily locates where and how big your imbalance is. The challenge is how you use this information to correct the imbalance on the shaft. Where to remove (grind off) some material? Or maybe a slight change to the assembly of the rotor is enough?

Proper balancing is guaranteed for every rotor that leaves the ABB Turbocharging factory. Balancing is, however, not a “for life” process. In operation, the balance of the rotor may be affected by various influences. Fouling is one of these. In particular, the exhaust gases from heavy fuel oil (HFO) contain solid particles that can be deposited on cooler surfaces anywhere between the engine exhaust gas valve and the exhaust stack. And there is no law which states that these deposits have to be evenly distributed!

Imbalance – part of turbocharger life

In the turbocharger it is primarily the nozzle ring and the turbine which are exposed to deposits of solid matter in the exhaust gases. Fouling on the nozzle ring influences the performance of the turbocharger by changing the aerodynamic shape of the vanes ABB Turbocharging so carefully designs and executes. Fouling on the turbine blade also affects the shaft and as stated, deposits
are never evenly distributed. Indeed, it is not only the material deposited on the turbine that can affect balance. The deposited material can be removed or displaced just as unevenly by various mechanisms – including turbine washing.

In addition, foreign objects in the gas flow may hit and damage turbine blades or the compressor wheel. The solid particles carried by the exhaust gases are abrasive, leading to uneven erosion of rotor material. And, finally, to complicate matters even further, while fouling, erosion or mechanical damage can be detected by eye, some influences are not even visible.

Hence – if you experience – or even suspect – any of these conditions, checking and balancing of the rotor by an ABB Turbocharging Service Station is strongly recommended.

What could happen?

As with your car, persistent imbalance will eventually cause wear and associated expense. A rotor that is out of balance moves laterally within its bearings. Small movements and forces are damped by the lubrication oil in the bearings and their supporting components. A larger imbalance will increase the wear on your bearings and force you to change them more frequently. You might also experience the turbine or compressor wheel rubbing against adjacent components (e.g. casings) due to increased shaft movements. In more severe cases of imbalance, higher vibrations in the turbocharger are noticeable. Or, in the worst case, a complete bearing breakdown can occur. Consequentially, the compressor wheel and the turbine blades also suffer significant damage due to rubbing, and will need replacing.

Reduced efficiency

During the period prior to replacement of worn blades, vanes and casings, turbocharger efficiency can be adversely affected due to aerodynamic and thermodynamic inefficiencies. In this regard it is worth noting that on the latest turbochargers, a 1% reduction in turbocharger efficiency can result in an increase in fuel consumption of over ½ gram per kWh, translating into as much as 30,000 dollars in additional fuel costs per year for a 10 MW engine.

Where to go

Our ABB Turbocharging Service Station network offers a rotor balancing service with worldwide coverage. Every station has qualified personnel and state-of-the-art automated equipment for accurate balancing within very tight tolerances. In fact, when opening a new Service Station, the balancing machine is one of the first tools to arrive and its commissioning is one of the main signals that the station is open for business.

Make balancing a “must”

Balancing the rotor is recommended as part of every overhaul performed in an ABB Turbocharging Service Station. When servicing the turbocharger in the field, balancing is recommended whenever time and distance to the next ABB Turbocharging Service Station permits.

Regular balancing throughout the lifetime of a turbocharger is essential for safe and long-lasting operation. It saves you cost in the long run.