

Turbocharger Damages

Introduction

Turbochargers are among the most technologically advanced engine component onboard ship. Impeller blades of a medium sized turbocharger regularly rotate at as much as 400 revolutions per second. The outer edges of the rotor blades thus move at 1.5 times the speed of sound.

In the process, the turbocharger digests contaminated exhaust gases of up to 700 degrees centigrade. Thus, the turbocharger is a very sensitive piece of high-speed machinery continuously serving in harsh conditions and under extreme strain. Being on the receiving end of gas flows, turbocharger damages are often caused by the failure of various upstream components.

As shipowners and ship managers are aware, damage to main engine and auxiliary engine turbochargers have a significant impact on the vessel's ability to trade. Damages can lead to costly repairs, significant reduction in speed while at sea and can be a considerable safety hazard.

These damages are costly to shipowners and shipmanagers as well as to Gard Services. For ships insured for Hull and Machinery through Gard Services in the period 1996 and 2001, there have been 192 incidents of turbocharger damages with total gross claims of USD 24.7 million. Taking into account deductibles, these turbocharger damages have cost shipowners and shipmanagers in excess of USD 25 million. Additional costs are accrued by shipowners and shipmanagers for turbocharger damages that fall below the deductible levels. As a result, this circular has been prepared as an assistance to the Members and Clients in the prevention of such costly damages to this critical part of the machinery system.

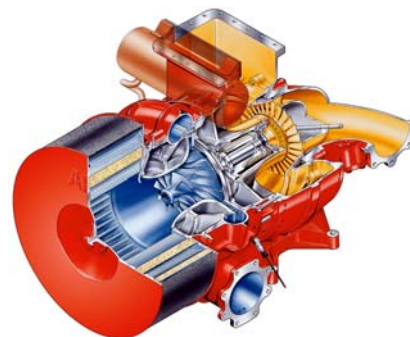


ABB TPL Turbocharger
Photo courtesy of ABB

Some major contributors to turbocharger breakdowns

1. **Late maintenance and overhauls.** In many cases, the service life of major components is disregarded. Not only bearings, but also compressor wheels and turbine blades/discs can have service life limitations. Compressor wheels, for instance, can be limited to between 50,000 and 100,000 work hours depending upon the use and configuration. This is equivalent to 7.5 to 15 years of use between exchange intervals. Due to operational and financial constraints, overhauls are occasionally postponed until dry-docking rather than overhauling while the ship is in service.

Obvious signals indicating that there are problems will at times be disregarded. Surging of the turbocharger can point to a clogged air cooler or fouled nozzle ring. Continued surging at full load might cause breakdown by itself. Further, rising exhaust gas temperatures may indicate that an inspection followed by service is required.

2. **Non-manufacturer parts used in place of manufacturers parts.** To reduce the costs of maintenance and parts, owners will use 'pirate' or 'alternative source' parts in place of manufacturer's parts. Due to the rough service environment of a turbocharger, inferior quality parts with slight discrepancies in material, design and dimensions can easily lead to damages.
3. **Maintenance not performed by manufacturer.** Maintenance costs for turbochargers can be significant. Maintenance undertaken by the crew, shipyard or other personnel not qualified by the manufacturer to perform such servicing can lead to improper maintenance and servicing. Below are listed a few examples of small mistakes which may eventually lead to total breakdowns:
 - Failure to observe the right fitting sequence may pre-damage components.
 - Failure to exchange key wear parts may lead to loss of functionality, for instance to loss of bearing lubrication.
 - Failure to observe the correct clearances of the assembly and to adjust the right true run of rotors may lead to rubbing of the rotor with consequential unbalance.
 - Improper cleaning of cover rings can lead to blade rubbing and consequent blade failure when installing overhauled rotors.
 - Lack of or Improper balancing of a rotor may damage bearings. (Due to the high speed, tolerances are extremely low).
4. **Missing service letters.** When there is a change of ownership of a vessel, the service letters and logbooks for the turbocharger, as well as other critical pieces of machinery and equipment can be missing. This break in information does not allow the new owners or shipmanagers the opportunity to assess the maintenance and services needs of the turbochargers.
5. **Inappropriate use.** Depending upon the ship's trade and operation, engines and turbochargers are sometimes specified for 'slow steaming'. When increased load demands are made on such equipment, some components may need to be replaced to match the new operating conditions. If disregarded, operational problems and/or reduced lifecycle of the rotating parts of the turbocharger due to elevated speed may result.

6. **Actual turbocharger is not appropriately matched to engine.** During vessel construction, turbochargers are rated for specified operating conditions. Engine conversions and changes to increase the power output places a greater load demand on the turbocharger and thus reducing the reliability and service time of turbocharger turbine wheel, compressor wheel and bearings.
7. **Upstream maintenance resulting in damage to the turbocharger.** In many cases, damages to turbochargers occurs when maintenance has been conducted on other machinery components or systems upstream of the turbocharger. Since the turbocharger is downstream of most other engine machinery, any foreign objects, loose parts, forgotten equipment or pieces of machinery equipment that may have not been properly reassembled may eventually move downstream to damage the turbocharger. Such items include loose bolts, injection nozzle fragments, compensator bellow bits, welding electrode stumps, wrenches and screwdrivers, rags or any other foreign objects. Due to the extreme service speed of a turbocharger, even minute particles may damage vital parts and lead to severe damage.
8. **Improper operation and maintenance by the crew.** Improper maintenance and operation by the crew can lead to damage to the turbocharger. The following is a list of some of the types of causes and events that can lead to more serious damages.
 - **Dirt on compressor and turbine blades** – Improperly implemented or neglected washing routines can let dirt accumulate on both compressor and turbine blades. This will lead to imbalances in the rotor, and consequentially it can cause bearing damages and even total break down.
 - **Improper lubricating oil** – The use of lubricating oils not recommended by the manufacturer or contaminated oil, can lead to reduced performance and eventual damage to the bearings.
 - **Improper cleaning and maintenance of filtration rings** – The intake air quality can be affected when air filters are not properly cleaned and/or changed. A clogged filter may lead to surging. In some cases, it has been observed that the crew, to keep from having to maintain and clean the filters, have removed the filtration rings.
 - **Turbocharger over-speed** – Due to incorrect maintenance or operational activities, turbochargers are in some cases over-spiced. When continuously over-spiced by only a few percent, this quickly damages turbocharger components and reduces their service life. An over-speed of 30-40% is likely to blow up the turbocharger instantly.

Recommendations

- *Only qualified manufacturer approved maintenance personnel should perform maintenance to turbochargers.* In most cases, the most qualified personnel to perform maintenance and overhauls are the manufacturers themselves where repairs can be performed while the ship is in service or at dry-dock. Some companies and shipyards are willing to perform turbocharger maintenance and overhaul at a 'cheaper' cost than the manufacturer. These reduced costs can be attractive to shipowners and ship managers. However, this cost can be based on a 'false economy' if damages occur due to inadequate maintenance and it can, in the end, be very costly to the owner and underwriter in settling a claim. Whereas, when qualified personnel perform the manufacturer's work, workmanship is more than likely under warranty.
- *Use the correct manufacturers replacement parts.* The turbocharger is a highly loaded, high technology engine component. Therefore, it is imperative to maintain and overhaul them with the correct parts. As with the maintenance work, the parts will also more than likely be under warranty.
- *Ensure that proper records of turbocharger service documents and letters are obtained and kept.* This is to ensure that proper maintenance and service can be scheduled. In cases where the service documents and letters are not available upon sale of the ship, the equipment manufacturer can often help with proper documentation and sometimes even with the turbocharger service history.
- *Operate the turbochargers within the operational design parameters.* Damages arising due to improper use can be very expensive and lead to operations at reduced speeds, a total breakdown of the turbocharger or loss of hire due to the need for maintenance and repair. Therefore, important parameters such as turbocharger speed and exhaust gas temperatures should be routinely monitored and if possible used as input to trigger alarms.
- *Ensure proper care and maintenance of the turbocharger.* Turbocharger care and maintenance are required at regular intervals and should be in accordance with the manufacturers recommendations. If in doubt, contact the equipment manufacturer for information on component service life. Proper care and maintenance include:
 1. Water cleaning of compressors and turbines to remove dirt and other residual material from the rotor to ensure proper balance.
 2. Regular cleaning and changing of air intake filters to prevent foreign objects entering and dirt and residue build up on the rotor blades. Furthermore, contamination of air intake filters results in a higher inlet restriction and may cause turbocharger overspeed or surging.
 3. In case of turbocharger separate lubricating system: Regular changing of lubricating oil (consult manual for approved oil) and cleaning of centrifuges as well as filters.
 4. Regular inspection of turbocharger parameters while in operation.

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