

# Sensor selection for monitoring complex extrusion gearboxes.

Large extrusion gearboxes represent some of the most complex machines used in industry. They often utilize six (or more) shafts, a dozen gears and twenty or more bearings. In deciding how to monitor the health of these machines, it is useful to begin with the end in mind. What are the failure modes against which one must defend? For the complex gearboxes discussed here, one is predominately concerned with rolling element bearing failures and gear damage.

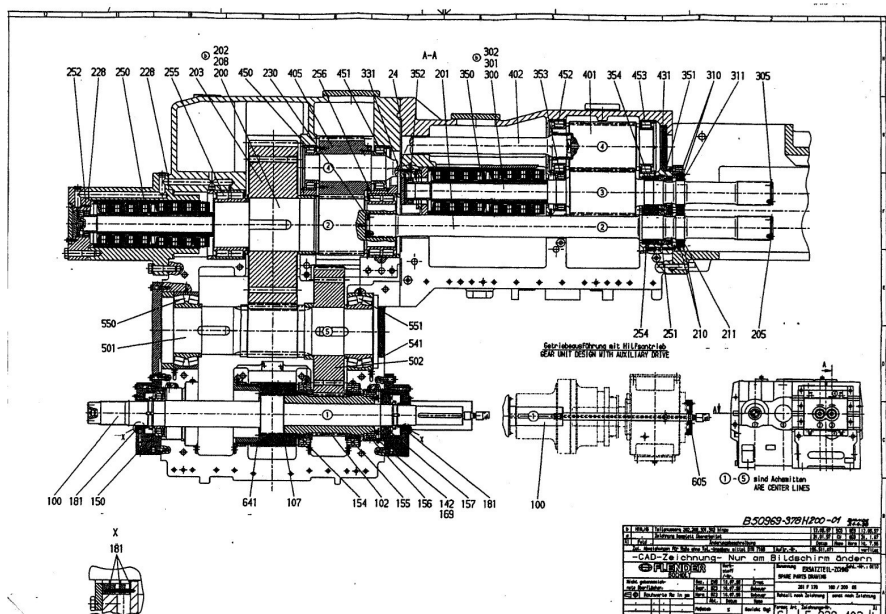
For simple machines (fans, pumps, etc.) misalignment, imbalance and bearing failure are usually considered as the most likely faults that must be addressed. Impellers can sustain damage, resulting in imbalance and there can be dynamic effects (cavitation, blade pass pulsations, etc.) but in general these systems are relatively simple and can be effectively monitored using portable data collection devices on a monthly (or biweekly) basis.

The bearings of simple machines are often very accessible, allowing the use of magnetic mounting the sensor, thus avoiding the cost of permanently mounting a separate sensor for each measurement location.

Since the fault frequencies of interest depend on the turning speed of the shaft and the geometry of the components involved, in some cases velometers may be used successfully (modern versions are essentially accelerometers with built in analog integration) but the normal practice in industry is to use accelerometers.

Velometers are the sensor of choice for detecting seismic activity like earthquakes and volcanic eruption, but not gearboxes.

Proximity probes are the preferred method for monitoring sleeve bearings. The data



collected is very simple – a gap voltage from each probe that provides a measure of the clearance between bearing and shaft. Unfortunately, meshing gears do not show up well, nor is this type of probe useful for early detection of faults in rolling element bearings (by the time the shaft centerline is affected due to bearing damage, the bearing will usually have sustained significant damage). Finally, proximity probes require holes be bored through the components to be monitored – expensive and intrusive.

Another class of sensors which have been used for machine health monitoring are accelerometers which have been tuned (or filtered) to be sensitive to the very high frequencies generated by early bearing distress. Such probes have the disadvantage that they must be mounted in very close proximity to the bearing being monitored – which is not a problem for simple machines, but for complex gearboxes requires that they be mounted

inside the machine. This is costly and ill advised for an aftermarket application (attempting installation in-situ risks contamination of the entire gearbox). Tuned sensors, with their short range of data acquisition, also tend not to be effective in monitoring gear health. So while this sensor type may, in theory, represent a reasonable approach to rolling element bearing fault detection, in practice systems that use these probes tend not to be effective for monitoring complex gearboxes.

Accelerometers are the most appropriate and effective type of instrument for diagnosing machines with both gears and rolling element bearings. Case mounted using threaded studs for ease of installation and high signal strength and linearity, these devices represent an effective and affordable solution. They may be installed without machine downtime and with the appropriate processing of the data provide an excellent understanding of machine condition.

*“All the normal bearing and gear faults can be clearly seen months in advance with the MTC system in place . . . without MTC you may not have much warning at all.”*

*Jim Dominiak, Extrusion Expert, Chevron Phillips Chemical*

**Monitoring Technology Corp.**  
phone: +1/703-698-5520  
[www.monitoringtech.com](http://www.monitoringtech.com)