MNG 311 Sea project
Assignment 5 – Intake and Exhaust Systems
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1. Before explaining what the different components of the Intake and Exhaust system do, and how the flow goes, it important to first explain the type of engines we are dealing with and how this will affect flow. The Main Engines (EMDs) are of a two stroke, four valve Uni-flow design. What this means is that intake of air is from an air box through ports in the cylinder liner. The air box is pressurized from a turbocharger in this instance. This also acts to scavenge the exhaust through ports in the head. In this case, there are four ports per cylinder, and each cylinder has it's own head.
   The SS Generators being Caterpillar D398Bs are a four stroke, two valve design. This means that instead of intake air coming directly into the cylinder through ports in the liner, air is taken in through an intake manifold which comes through a port in the cylinder head. The air is sucked in by the downward pull from the piston, although there is pressure from the turbochargers. After combustion, the exhaust valve opens, and the act of the piston rising pushes out (scavenges) the exhaust. To make it clear, unlike the EMD which intakes fresh air and scavenges exhaust at the same time, the Cats on here intake air and scavenge exhaust in different cycles. The cylinder heads on the Cats service two cylinders. Therefore there are 4 valves per head.
   Both of these principals are shown in the included flow diagram. Now the purpose of the different components of the intake and exhaust systems will be explained.
   Air filter
   Pretty self explanatory. This filters the intake air before it enters the engine. On the Cats, one air filter gets changed out every 750 hours. On the EMDs, the air filters are changed out two times a year. Once at the end of August, and once at layup.
   Turbocharger
   The turbocharger is used to pressurize the intake air, allowing more air to enter the cylinder, and allowing for more fuel to be burned. This increases the power output. The turbocharger is operated by the exhaust gases leaving the engine. If it isn't broke, we don't fix it.
   Aftercooler
   The air leaving the turbocharger is heated. The purpose of the aftercooler is to cool that air down, allowing denser air to enter the engine. The heat is transferred from the air to the jacket water on the EMDs, and to the Raw Water on the Cats.
   Air box/Intake Manifold
   The Air box, on the EMDs, and Intake Manifold, on the Cats, are what deliver the air to the cylinders. As stated earlier, the air box pushes air into the cylinders via the air ports on the EMD, and the intake manifold connects to the cylinder head, where the air enters the cylinder through the intake port. These are pretty maintenance free.
   Exhaust Manifold
   The exhaust manifold is where the exhaust leaving the cylinders collects. In the case of the EMDs, there is only one exhaust manifold for the entire engine. On the Cats, each bank of cylinders has its own manifold. The manifold is what goes to operate the turbocharger, and from the turbocharger, the exhaust goes out through the stack. Yet another maintenance free item.
2. As shown in the LO flow diagram for the Main Engines, lube oil going to the

turbochargers first goes through the turbocharger filter. This is in addition to the main filters. From this filter, oil goes to lubricate the turbocharger, as well as the associated gearing. When the soak back pump is operated, oil comes from the sump, goes through the pump, and then through the soak back filter. The soak back filter then runs through the turbocharger filter housing, but not actually through the filter. In fact, check valves are in place so that under normal operation, oil from the turbocharger filter isn't going back through the soak back filter, and visa-versa.
An alarm for low turbo lube oil pressure is set up for each engine. If this alarm goes off, the proper action would be to declutch and shutdown the affected engine. This would then start the soak back pump, and assuming that the soak back pump is able to provide pressure, let the turbo cool down properly, and allow for inspection of the cause of the problem without damage to the turbo.

3. Operation of pyrometers is performed via a basic method of current generation. Most metals when heated have the property of electrons leaving the heated area and seeking the colder area. Some metals, such as Iron, however have the opposite property, where electrons come to the heated area. If these two metals are connected at their cold ends by, let's say, a current meter, a circuit is made, and the current flow will be indicated by the meter. The hotter the heated end, the higher the voltage, and assuming a constant resistance, the higher the current. Therefore, pyrometers operate with a design in mind whereby a certain temperature correlates to a certain voltage, and with a constant resistance level taken into account, a certain current. Thermocouples don't operate on the same principal of a mercury or alcohol thermometer, which heat is measured by the expansion of the material, but rather by a current generated by the above reaction. Maintenance performed on the system would only be cold end calibration, but our units already have a compensator for that.
4. The intake pressures taken on the main engines are from the air boxes on the main engines. Pressures are indicated on a gauge in the control room. We use the air box pressure as a rough indication of how much of a load the engine is under. At full speed, the air box pressure usually runs around 17 psi. If the pressure seems abnormal, we would then look at the rack position to get a better idea the load the engine is under.
   Exhaust pressures on the other hand are not taken on this ship.
5. Given that the EMD diesel is a two-stroke engine, the only valves it has are four exhaust valves. Two valves on each side of the head are operated by a bridge. Both bridges connected to their own rocker arms, which are actuated by the camshaft. Since we are dealing with a two-stroke engine, the camshaft rotates at the same rate as the crankshaft. Unless the relationship between the camshaft and the crankshaft have been changed, or new gears are installed in the camshaft gear train. To prevent missalignment, it is advised to, if possible, bar the engine over so that the alignment marks on the left bank camshaft gear and the No. 2 idler gear are aligned. In the event that the camshafts have to be re-timed, only one cylinder per bank has to be set. Timing has to be set so that the valves are **not** open earlier than 104^{o} after top dead center, and no later than 110^{o} after top dead center. See the included diagram to see the gear train.
   As stated in the discussion about the lube oil system, the valves and running gear are lubricated by oil which is delivered from the hollowed camshaft to one camshaft bearing per cylinder. From the oil collected by the bearing, the rest of the running gear is lubricated.
   In terms of inspection and maintenance on the exhaust valves, not much is done on

the boat. As with a lot of other things on this ship, if it isn't broke, we don't fix it. We do top ring inspections every month, and can change out a power pack if one fails, but normally, the only time power packs are changed are when the engines are due for overhaul, and then we contract out a third party company, Peaker Services, to do the overhaul and maintenance on the power packs. Currently, time intervals between overhauls are three years, but there is rumor about trying to go four. Obviously this would be a bad decision if power pack after power pack has to be changed out on the run, which can mean a lot of downtime.

6. The air can get into the engine room by two ways: through the gangways and through the ventilation system. When we are underway, if water isn't pouring inside, we leave the gangway “windows” open. We also run the ventilation system as well even when the windows are open. There are two speeds for the ventilation fans, fast and slow. When we aren't running the main engines, we run the engine room ventilation on slow. During fueling operations, we have to shut down the engine room ventilation fans, which take suction next to the boom. This prevents the diesel fumes from entering and collecting in the engine spaces, reducing an explosion and fire hazard.
   The only real regular maintenance on the system we perform is moving the rolling air filters when the section gets too dirty. We can tell that the filter section is dirty without going into the filter room by looking on the differential gauge on the bulkhead. When it reaches a certain level, a new section of filter is rolled into place. When a roll is all used up, it is discarded, and a new roll is inserted.