Duty Cycle Cranes for Clamshell and Dragline

Before we start, one word of caution….don't buy a liftcrane that has duty cycle as an option…buy a duty cycle crane that has liftcrane as an option.

How many ship and barge unloading operations, dragline operations and dredging operations are there in the United States ?

What equipment is available for duty cycle work?

Considering the number and economic importance of these operations, it is surprising that very few people reading this editorial realize that true duty cycle cranes do exist and don't cost much money. They are cheaper than the equivalent excavator.

What makes a crane duty cycle?

Horsepower…..you need horse power to do work, it is that simple. Big liftcranes being used for clamshell typically have 450 hp engines. In a sinmilar size duty cycle machine, look for 750 hp or more. The smallest duty cycle cranes will have 300hp or more.

Construction of the Upper….liftcranes are built up from two rails that carry bolt-on winches, counterweight and remaining components.

Duty cycle crane uppers consist of a heavy bedplate to which very heavy and deep side plates are welded. The entire upper including the boom trunnions is built as one piece and then line bored for mounting the components.

The following photograph shows a duty cycle crane upper having the mechanical components installed.

Construction of the Lower

In liftcrane design, the lower is built lightweight and pins together for fast dismantling. Apart from being expensive, in long term duty cycle work, this is a real problem as the pin holes become worn and elongated and the machine becomes loose.

In a duty cycle machine, the entire bottom is one weldment including the axles and the crawler side frames are heavily bolted to the center frame. This gives a very solid, rigid and heavy base for the crane which will not "loosen" over time.

Look for large diameter shafts, heavy track rollers and massiveness. Liftcranes just don't have it.

Single Layer Winches, 4-Rope Design

For duty cycle work you need to have all your wire rope on one layer of the drum, including the boom hoist wire, to ensure long rope life. This can only be accomplished when you have ropes dead ending on both ends of the drum

The photograph above illustrates the concept. Note two ropes coming from each drum, one from the right

which is a right lay rope and one from the left which is a left lay rope.
The ropes go straight up the boom over very large diameter sheaves down to the clam. The clam is equipped with an internal reeving wire that connects to the closing ropes. The two holding ropes attach with chain sections to the top frame of the clam. This principle is shown in the photograph below.

The right and left lay ropes offer the advantage that the clam is very stable and does not require a tagline. This is very important if you are unloading ships where the tagline rubs on hatch coamings and in dredging operations where the clam extends well below the base of the crane. In standard configuration, a 4-rope crane can dig as much as 100ft below the base of the crane.

The boom hoist is also designed to take the rope on one layer of the drum and is designed for continuous high speed booming needed in clamshell work and breakbulk.

Line Speed

The question of line speed is really a question of horsepower. In order to achieve high cycle times, hoisting velocity of the full load should be as much as 230 fpm and hoisting down should be in excess of 300 fpm. The engine must be sized to allow hoisting, swing and luff at full speed simultaneously without exceeding 85% of the engine rating. For example, PLM cranes of the Netherlands offers a 4yd machine as the smallest in their lineup with 350hp and in their 30yd machine, 1500 hp. Roughly you need 100hp for every 100 tons per hour of handling rate.

Slew Bearing
Before you look at the bearing, first look a the construction of the upper and the lower. These must be very stiff, deep and heavy structures that will not flex during high speed duty cycling.

The next thing to look for is large diameter of the ring to ensure high capacity and large radius for the swing pinions. Rolling elements must also be very large, 2 inch diameter in the case of ball bearings. On larger machines, some makers use a triple roll roller bearing design.

The slew bearing must be designed for at least one million cycles under full load.

Hydraulic Systems

The first thing to look for is closed loop design. In closed loop systems, each function has its own pump and pressure is created only when demanded.

In open loop machines such as lift cranes and excavators, the pump is continually supplying oil under pressure to a valve manifold that directs oil to various functions. This creates a lot of heat and results in short life of the pumps.

Closed loop hydraulics operating at 2500 psi to 3000 psi are really what you need to get long life, high reliability and avoid heat buidup.

In a closed loop crane, look at the operating pressures, quality of the pumps and motors and above all make sure the cooler is well oversized. For example, PLM uses Mannesman Rexroth pumps and motors running at about 2500 psi and installs hydraulic cooling equivalent to 50% of the diesel engine horse power.

Control Systems

This is where liftcranes and duty cycle cranes really diverge. Lift cranes are equipped with sophisticated electronic load moment devices that will not be reliable in high speed continuous duty cycle work where loads come and go very quickly and high acceleration loads are experienced.

Acceleration loads are usually ignored in liftcrane design because they are low.

Duty cycle cranes use pilot line control or electronic control. Pilot line is the least cost and is simple and reliable. If more sophistication is needed, electronic systems are provided but they are very simple and are designed for use at sea.

Duty cycle cranes are equipped with dual mode systems. In clamsghell or dragline mode, boom angle is displayed digitally in the operators cab however the load is not indicated. Load is controlled

by the size and opening of the bucket and sensors built into the winch circuits that prevent hoisting loads which are too heavy.

Boom is controlled by limit switches to prevent working outside the safe range. The Operator is free to concentrate on his load and never needs to look at the radius indicator nor load indicator and is never shut down by sophisticated electronics.

Ease of Operation

Hydraulic duty cycle machines are a dream to operate with only two joysticks to look after. There are no frictions, no brakes, no footpedals. This means that any operator who is comfortable around heavy equipment can be trained within a few days and will obtain high level performance very quickly.

Multi-Function

Look for a crane that is designed as a duty cycle machine that has liftcrane as an optional feature, not a liftcrane that offers duty cycle as an option.

In duty cycle machines, a selector swith is provided in the cabin for clamshell, dragline or liftcrane to enable the machine to be used for breakbulk, bulk and dragline. The photo below shows the lifting block used for breakbulk and liftcrane on a four wire crane.

In a 4-rope crane, the winches are automatically locked together so that the holding and closing lines work together without operator input.

Maintenance

The photograph below shows what is available. The side panels of the crane are raised hydraulically and cover the mechanic to protect from the elements. All the components are righ in front of him and no dismantling is required to get to any component.

Lights are provided inside the covers. These machines are designed for ease of maintenance and a lot of effort goes into making the machine “mechanic friendly”

The entire drive train can be removed and replaced within one day.

PLM offers a diagnostic package with the electronic control option that allows the mechanic to plug in a laptop or dial up from remote location to diagnose the crane.

PLM are able to diagnose your crane remotely from their factory.

Corrosion Protection

Is your crane designed to last for 20 years at sea ?

The photo above shows a PLM 3520 mounted on a 41,000 dwt ship in a North Atlantic storm.

The best cranes are grit blasted after all welding has been completed and are coated immediately with zinc rich epoxy. Two additional epoxy anti-corrosive coats are applied followed by a polyurethane top coat. It does not get any better than this.

If the crane you are considering is not prepared and coated properly and is exposed to corrosive conditions, it will not last.

Boom and Sheaves

Look for very heavy boom construction with large diameter heel pins and large diameter sheave axles. The structure should be very heavy and dimensionall very large, particularly at the heel to take heavy side loading.

Chord sections should be thick and robust and must be designed as compact sections. Chords must also be thick and heavy to withstand years of corrosive service.

Sheaves must be heavily constructed with very wide bore, large diameter and open throat design for heavy side loading.

If your sheaves don't look like the ones in the above photo, you have a liftcrane.

Automatic Lubrication

Autolube is a standard feature on duty cycle cranes to ensure that as the crane is working, all points such as slew bearing, slew pinion, head sheaves, boom sheaves and boom trunnions receive grease. This adds enormously to the life of you crane.

Cabin and Comfort

A duty cycle crane for barge and ship unloading will come equipped with hydraulically raised and extendable cab as standard equipment. This gives the operator clear view over the cargo holds.

Standard equipment must include heating,a/c climate control, cd/radio player and you must have the most comfortable seating available.
Duty cycle work requires a lot of concentration and operator fatigue is a primary design issue. Your productivity depends on it.

Longevity

Ask your dealer to provide you with a spreadsheet of maintenance items costed out to 40,000 hours, including overhauls and re-engining at 20,000 hours.

The best machines are designed for 40,000 hours of continuous duty cycle work. At 40,000 hours, the draw works and drives are replaced and the crane is good for another 40,000 hours.

PLM designs their cranes for 5000 hours of use annually.

See if your liftcrane can do this.

Parts and Service

Make sure that all the components on your crane are available to you directly from the manufacturer of the part. The best crane makers give you all the part numbers to allow you to purchase directly or through a dealer.

Make sure there is trained service available within one days drive and make sure all components are stocked either by the dealer or at the factory.

Multi-Function

With the control system avalable to-day, the best duty cycle machines can be used as clamshell, dragline or liftcrane and can be mounted on crawlers, rubber tires or pedestals.

They are also designed specifically for use onboard ships and barges for dredging work where high side pulls, heavy swing loads and high breakout forces are encountered.

For example, you may have an operation where the pit can be easily extended by dragline but in the future you want to go deeper. Ideally you can procure one machine that can work as a dragline and then convert instantly to clamshell dredge and work from shore, off a barge or pontoon.

With electronic cranes it is a very simple matter to install management systems with GPS for dredge production monitoring and mapping.

PLM offers floating crane platforms for loading and unloading ships at anchorage from barges up to panamax size ships.

Costs

Look for a machine with low operating costs but remember, hp means fuel means production so look at fuel consumption separately from maintenance costs. Don't be attracted by low fuel consumption because it also means low production in duty cycle.

One large machine will always be cheaper than two smaller machines of equal capacity not only in capital cost but operating cost.

Machines range in size and capacity but look for the price of a 15,000lb capacity crawler at 56ft radius capable of 300tph barge unloading to cost in the neighbourhood of $550,000.00 and go up from there.

These machines retain their value far better than other machines available. After 10 years of hard working, you can expect the value of your machine to be better than 70% of the new price.

PLMs are in high demand and if you decide to cease operations or your project has reached completion, your machine can easily be re-sold at very high residual value within a very short time.

Look for machines with high horsepower, high line pull, high line speed under full load and don't buy sophistication that you don't need.

Keep the machine rugged, simple to operate, easy to maintain and high powered. Do not expect this from a liftcrane.

Many operators struggle along with older friction machines arguing that the machine was cheap to buy and it gets the job done.

Invariably when you look at the savings in maintenance costs, service personnel, rebuilding cost, wire rope useage and increased production you get with a new crane, it is usually possible to justify the costs of a new PLM with full capital recovery in less than 5 years. The higher your annual tonnage, the easier it is to justify.

Summary

Before you buy an excavator for unloading barges or a suction dredge for your pit or a dedicated dragline for your operation, look carefully at the duty cycle 4-rope cranes.

You will be surprised.