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JetTorque

A Technical and Commercial View of the Waterjet Propulsion Market from HamiltonJet

FROM THE BRIDGE

High speed surface craft continue to grow, in size, in design variants and geographic distribution. Followers of these trends will be well aware of the dominance of waterjets as the preferred propulsion option for the majority of modern high speed craft.

The high speed passenger ferry market is a good indicator of the wide acceptance of this propulsion system. According to a recent survey by industry observer Cruise and Ferry Info, a large proportion of the worlds fast ferry fleet is now waterjet powered. Their study showed the rate of waterjet installations to be growing at almost 30% per year whereas the use of conventional propellers is in decline for such craft.

Keeping pace with the technological advances in ship design has been HamiltonJet's own Research and Development programmes, ensuring designers and builders have access to propulsion systems that are in tune with today's market requirements. The in-house TQM programme, FOCUS, empowers all personnel with the responsibility of continuous improvement in all areas of design, manufacture and marketplace servicing. Many new developments from the programme are now coming on stream, providing new models and features to the already expansive product range.

R & D Initiatives Come On-Stream

BIGGER ....

HM Series waterjets, extending the Hamilton range to models for craft up to 60 metres long, have established themselves in this end of the work and patrol boat market.

Jaguh, a new 56 tonne Royal Malaysian Customs patrol craft equipped with twin Model HM571 jets achieved a maximum continuous speed of 32 knots during trials, easily exceeding the 28 knot contract design speed.

Other HM Series jet applications include crew boats for the Malaysian oil fields, an 18 metre pilot boat for the Dutch Pilots Association, patrol craft for North Africa and loiter / boost propulsion application in new Hong Kong Marine Police patrol craft.

HM Series jets offer designers and users many of the features available throughout the Hamilton range - outstanding manoeuvrability, even at zero speed, easy maintenance with inboard hydraulics and controls, factory supplied integral transition duct, rigid bearing housings and demonstrated cavitation resistance.

ROYAL MALAYSIAN CUSTOMS PATROL CRAFT - TWIN HAMILTON HM571 JETS

FASTER ....

The new HS Series of multi stage waterjets designed specifically to operate in the 40 - 65 knot speed range are proving to provide a first choice option for designers of extra high speed craft.

Optimised for high propulsive efficiencies at fast boat speeds, these jets have a high power density enabling the power requirement to be absorbed by a relatively small propulsion package.

A recent example of this is a prototype high speed craft developed by Marine Turbines Australia Pty. Ltd. Fitting out a Riviera Diavolo 44 hull with a single HS363 jet driven by two Allison C30 gas turbines through a combining gearbox, a top speed of 60

knots was achieved during trials. Even on only one gas turbine, speeds in excess of 30 knots were achieved.

This propulsion combination offers a very high power to weight ratio in a high speed hull and is particularly attractive for applications such as mission specific craft for pursuit and interception duties. Normal patrol duties can be carried out economically on one turbine only, but if called upon to maintain high speeds, the second turbine can be employed at any time.

Other HS Series applications include a multi craft order for a Spanish Maritime Authority.

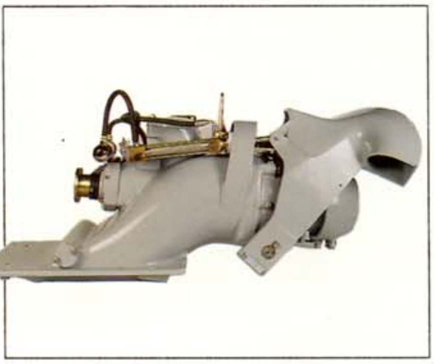
BETTER ....

Astern deflector control systems have also received the attention of Hamilton engineers. HSRX control is the result of intensive investigations and incorporates many innovations.

Featuring an actuating cylinder with integral rotary valve, the patented system incorporates a jet mounted hydraulic pump, an arrangement that completely eliminates the need for the shipyard having to undertake any hydraulic piping.

HSRX is a "follow-up" system where the astern deflector movement follows the control lever movement. Greater sensitivity, especially at the zero speed position is exhibited and as the control lever is not directly linked to the astern deflector, lever movement is very easy and can be as fast as the operator desires. The packaged nature of this system allows HamiltonJet to fully test run the system prior to despatch for easy on-board commissioning.

HSRX control has been incorporated into the HamiltonJet model 273 and can be retrofitted to push-pull cable equipped versions of this model already in the field.



SLIP OR GRIP - Is It Cavitation Or Aeration?

Cavitation and aeration - two often confused phenomena that affect waterjet performance to varying degrees.

With a little understanding of these phenomena and their causes, designers can plan to minimise their effects.

Aeration

When air enters a waterjet, it can attach to areas of low pressure on the suction side of the impeller blades. Less room is left for solid water to pass between the blades, resulting in a reduction in water flow and consequently jet thrust.

In practice, there is always some air entrained in the water flow to the jet caused by the air / water interface at the craft's bow and a waterjet will handle this limited amount of air with no reduction in performance.

However, often external factors can cause this water flow to become excessively aerated, resulting in a loss of jet thrust. Excessive aeration would be indicated by a rise in engine rpm with a simultaneous drop in boat speed.

To ensure design jet thrust is achieved, designers and builders should be aware of the factors that can cause excessive aeration:-

-shallow vee hulls with blunt or full bow shapes create a heavily aerated bow wave which is rolled back under the hull into the jet intake. Deep vee hulls with sharp vee'd bow stems cause least aeration.

-Multi hull forms, particularly tri-hulls, tend to trap air between the hulls.

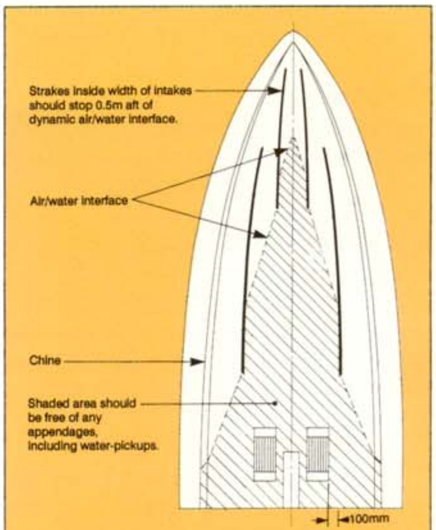
-Planing strakes, keelsons and flattened central keel areas can all cause air to be channelled aft into the jet.

-Appendages, water pickups etc located forward of the jet intake can cause aeration by redirecting aerated flow into the jet intake.

-Jet intake installation should merge smoothly with the hull profile aft of the intake, with no steps or ridges.

-Exhaust outlets should be positioned above the waterline to avoid recycling exhaust gasses into the jet intake during astern operation.

-Excessive trim angle rolling the bow wave air into the jet intakes.



RECOMMENDED UNDERWATER HULL CONFIGURATION TO MINIMISE TURBULENT WATERFLOW TO JET INTAKES

In most cases, designers can readily minimise the effects of aeration taking the above factors into account.

Operational parameters can also affect the jets capability to resist aeration. At high boat speeds, positive ram pressure will be present at the intake. Any incoming air bubbles will then reduce in size before reaching the impeller so considerably more air can be tolerated without significantly affecting the jet thrust performance.

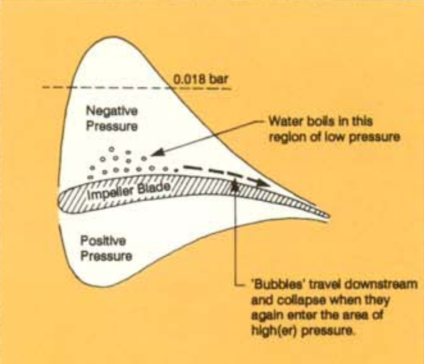
However, at low boat speeds and high power inputs, such as occurs at 'hump' speed when a craft is accelerating onto the plane, the intake pressure is very low and incoming air bubbles expand very rapidly before reaching the impeller.

Under these conditions, even a small amount of air can cause breakaway - where the jet thrust reduces noticeably and the engine revolutions rise to the governor setting.

Cavitation

By contrast to conventional propellers which can run into cavitation problems at high speeds, waterjets can be affected at lower speeds.

Cavitation is the rapid formation and collapse of vapour cavities within a liquid, caused by a localised drop in pressure usually associated with high local velocities. The impact of the collapsing fluids against a metal surface leads to very high local pressures (up to 1000 Mpa) which are beyond the strength of most materials.



DIAGRAMMATIC REPRESENTATION OF VAPOUR CAVITATION

The jet impeller is most likely to suffer cavitation erosion damage but in the worst conditions the stator blades and tailpipe housing can also be damaged.

Cavitation occurs in waterjets when:-

-Excessive power input is used at low boat speeds.

-The inlet is partially blocked with debris or is too small.

-There is an external factor causing turbulent water flow into the jet, such as a water pickup or other hull appendages.

-Blunt or damaged impeller blades.

-Craft trim and load are excessive.

-A common cause of cavitation damage is when a jet propelled craft is required to tow another craft. This often requires the towing craft to operate at high throttle settings with low boat speeds for long periods of time.

If cavitation conditions are being experienced in an existing installation, cavitation may be supressed by increasing the boat speed slowly. This would be done by only applying full throttle when the craft has reached, say, 20 knots.

An alternative to this can be a reduction of boat weight, relocation of LCG or the fitting of trim tabs, all which will contribute to lowering excessive hump resistance to avoid the requirement for high throttle settings at low boat speeds.

A small amount of cavitation may be eliminated in some instances by fitting the waterjet with a smaller nozzle. This effectively reduces the waterflow through the jet but it should be noted that reducing below the optimum nozzle size tends towards a smaller, less efficient, jet.

The best solution is the correct selection of jet at the design stage, based on realistic craft statistics, and careful control of boat weight during construction.

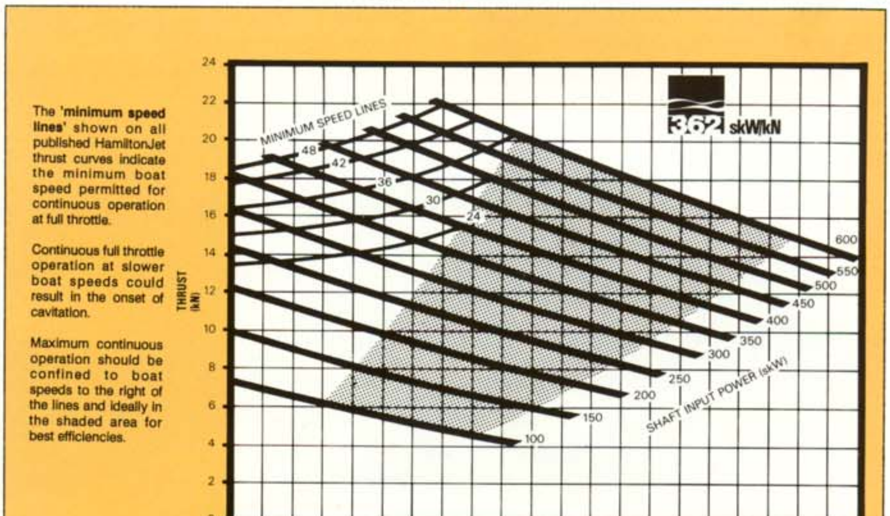
Features to look for in waterjet design to offer best cavitation resistance are:

-Greater impeller blade area, such as long blades or more blades of the same area. Pump efficiency may reduce as blade area increases due to the frictional effect of the increased surface area. To provide cavitation resistance, manufacturers make a practical compromise between cavitation resistance and efficiency - Hamilton Jet offers a range of impeller options for each model which enables an optimum jet to be available for most applications.

-Blade loading . The blade profile determines the load distribution across the blade surface, a critical factor for cavitation performance.

-Overly large inlets will aid cavitation performance but, as craft speed increases, a large inlet can cause additional hull resistance.

Thrust curves published for each model Hamilton Jet all show minimum speed lines, indicating the minimum boat speed for continuous operation at full throttle. By superimposing the craft's resistance curve over these, designers are easily able to determine the cavitation margin available. The 'minimum speed lines' shown for each impeller option are the minimum speeds that the craft can be continuously operated at without risk of cavitation damage occuring. It is acceptable to pass through these lines quickly during the planing transition but continued operation at speeds lower than those indicated will result in cavitation errosion damage to jet components.



TYPICAL JET THRUST CURVES SHOWING MINIMUM SPEED LINES

FROM THE LOG BOOK

Hamilton Jet To The Rescue

Hamilton waterjets are used widely in rescue craft applications around the world. Meeting the stringent requirements of leading certifying authorities for use on MOB craft on North Sea standby vessels, offshore Coast Guard vessels and similar, some such craft have recently been in the news.

On Australia's Queensland beaches, rescue craft fitted with Hamilton 211 jets driven by Volvo KAMD 42 diesel engines are called upon to operate right in amongst the heavy surf. Surf Life Saving Queensland Inc.'s recent Annual Report details a total of 185 life saving rescues made by the craft during 12 months.

HAMILTONJET POWERED BRAVO 107 CRAFT PULLS RACING YACHT FROM ROCKS

AUSTRALIAN JET SURF RESCUE BOAT IN ACTION

In Canada, Hamilton 291 jet powered Quick Response fire boats were described by Fire Chief Bob Babcock as "playing a very integral part in fighting this fire" following their performance at a recent waterfront blaze.

The 12.2 metre twin jet craft supplemented the land based assault on the fire, enabling it to be totally surrounded and contained.

ONE OF PORT VANCOUVER'S NEW HAMILTONJET POWERED FIREBOATS

And, in the last Round Britain Yacht Race, when competitor BPA Dumptruck went aground on rocks on the coast of N.E. England, a Marshall Branson Marine Bravo Landing Craft came to assist.

The shallow draught and outstanding manoeuvrability attributable to the 211 Hamilton jet drive enable the craft to close the yacht initially to salvage gear and later to make fast a line to careen the yacht. With the keel freed from the rocks, the yacht was eventually towed to safety.

It is reported that only the expertise of the crew and the superb handling of the Hamilton powered Bravo saved a fine yacht from certain destruction.

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