SCIENTIA RERUM NAVALIUM

The South African Institute of Marine Engineers & Naval Architects

The
Two Oceans Journal

2023 / 2024 Edition

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Kevin Watson	(Secretary)
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Presidents Report (end of 2024 message to members)

Dear SAIMENA Members and Colleagues,

As we approach the end of another year, I extend my heartfelt gratitude to each of you for staying engaged and connected through our SAIMENA network. Your commitment and resilience remain the cornerstone of our community, and I am deeply inspired by the strength and dedication you continue to show.

This year, the world has navigated turbulent waters, from global conflicts to economic instability. Despite these challenges, humanity has shown remarkable resilience. We've witnessed individuals and industries adapt, rebuild, and persevere. For many of us, these global events are not distant headlines but personal stories—friends and colleagues displaced by war, families uprooted, and yet, the determination to press on remains unshaken. These experiences remind us of the power of hope and unity, even in the most uncertain times.

The festive season, a time of goodwill and reflection, offers us a unique opportunity to focus on the values that bind us—kindness, generosity, and compassion. It is a time to look beyond ourselves and ask how we can make a difference, however small, in someone else's life. Whether through a gesture of kindness, a word of encouragement, or offering guidance to those in need, let us commit to being catalysts for positive change in the year ahead.

The maritime industry continues to face its share of challenges. From the evolving demands of inspections and compliance to the critical issues of crewing, education, and shipyard operations, we are navigating complex and often uncharted waters. Yet, with challenges come opportunities:

Education and Skills Development: The growing interest in maritime studies is a promising trend. While there are hurdles to overcome in aligning qualifications with industry needs, we are working diligently with decision-makers to create pathways for the next generation of maritime professionals.

Shipbuilding and Repair: The state of our shipyards and dry docks requires urgent attention. Modernization and strategic planning are key to positioning South Africa as a competitive player in the global maritime sector.

National Maritime Identity: The absence of a national carrier and the outsourcing of freight handling to foreign entities are pressing concerns. These challenges demand innovative solutions and a collective effort to restore South Africa's prominence in global shipping.

Amidst these complexities, we must also celebrate the progress we've made and the opportunities that lie ahead. Together, as a united SAIMENA community, we can continue to advocate for change, drive innovation, and uphold the standards of excellence that define our profession.

As the year draws to a close, I encourage you to take time to cherish what truly matters—family, friends, and the spirit of hope that the festive season brings. May this season inspire you to reflect, recharge, and look ahead with optimism and determination.

On behalf of SAIMENA, I wish you, your loved ones, and your shipmates a joyful and peaceful festive season.

May the New Year bring renewed purpose, prosperity, and success to us all.

Stay safe, stay strong, and keep striving for excellence.

Rennie Govender, CEng CL1 Chem/Tanker, FSAIMENA
SAIMENA President

The Editors Desk

In 2023 the TOJ editor for many years handed over the editorial lead to a new member, Jacques de Klerk. Having large and experienced shoes to fill Jacques managed to put together this edition of the TOJ supported by Iain Armstrong, who passed away in 2023 and will be missed by the SAIMENA community.

Struggling with sourcing adequate material for the TOJ (members please assist here in future) and the need to move on in his career, Jacques was not able to get the TOJ published.

This edition is thus dedicated to Iain and also consolidates the material that was collected and put together for publication.

SAIMENA is now urgently searching for a volunteer to take over the editorial work of the TOJ, so that the published mouthpiece of SAIMENA can be published again. |
The TOJ will thus be held in abeyance till we can find a volunteer.

Please do send any material of own articles that you may have or pen to SAIMENA so that we can collect articles to publish in the future.

Kind regards

Kevin Watson
Hon Secretary SAIMENA

Arrivals, Departures and Losses

Membership Status Changed 2023

Accepted as MARITIME PARTNER

Member No	Name	AuditDate
MP1-2023M01	ANE Industrial Supplies	02-Jun-2023

Accepted as FELLOW

Member No	Name	AuditDate
F2012013	C. Fourie	31-Aug-2023
F2023001	H.W. Theunissen	12-Feb-2023

Accepted as MEMBER

Member No	Name	AuditDate
M2023004	D.P. Khumalo	14-Dec-2023
M2005009	S.G. Brown	26-Sep-2023
M2023003	C.R. Morar	18-Jul-2023

Accepted as ASSOCIATE

Member No	Name	AuditDate
A2023005	A.M. Kabeya	03-Aug-2023
A2023002	P.G. Botshelo	06-Apr-2023

Accepted as RETIRED FELLOW

Member No	Name	AuditDate
RF1989027	G.W. Meyer	13-Aug-2023

Accepted as RETIRED MEMBER

Member No	Name	AuditDate
RM1995019	C. Rooney	13-Aug-2023

Accepted as STUDENT

Member No	Name	AuditDate
S2023S003	S. Vena	18-Jul-2023
S2023S001	N.S. Madhawu	08-May-2023

13 January

Accepted as STUDENT

Member No	Name	AuditDate

Upgraded to Fellow

Member No	Name	AuditDate
F1986015	M. Mc Williams	19-Apr-2023

Upgraded to Member

Member No	Name	AuditDate
M2020006	J.F. de Klerk	06-Apr-2023

Re-instated, fees paid

Member No	Name	AuditDate
A1999006	B.L. Fynn	20-Aug-2023
A2016003	S.N. Malimba	20-Aug-2023
A1986003	S.A. Malpas	19-Apr-2023

Deceased

Member No	Name	AuditDate
HF1983026	I.F. Armstrong	21-Sep-2023
M2015007	S.T. Atkinson	14-Jul-2023
F1987003	K.A. Zajaczkowski	20-Mar-2023

Resigned

Member No	Name	AuditDate
A2009008	G.M. Thompson	12-Dec-2023
M1983031	G.J. Roos	30-Apr-2023
M1994008	S.H. Marshall	16-Apr-2023
M2004001	M. Allen	05-Apr-2023

Suspended as No member reply

Member No	Name	AuditDate

Membership Status Changed 2023

Suspended due to no fee payment.

Member No	Name	AuditDate
A2008004	R.B. Albert	08-Aug-2023

Membership Status Changed 2024

Accepted as MEMBER

Member No	Name	AuditDate
M2024001	J. Phillips	12-Aug-2024
M1981003	G. Mohamed	02-May-2024
M2019009	C.A. Turnbull	04-Mar-2024

Accepted as ASSOCIATE

Member No	Name	AuditDate
A2024002	M. Paulsen	23-Nov-2024

Deceased

Member No	Name	AuditDate
RA1979035	C.J. Vaughan	22-Jul-2024
F1984007	T. Baker	28-Jun-2024
M1975184	C.R. Hicken	29-Mar-2024
RF1975041	G.G. Haddow	03-Mar-2024

Resigned

Member No	Name	AuditDate
A2017005	L. van Blommestein	25-Aug-2024
A2012011	D. Govender	23-Jan-2024
A2009019	H.H. Wilmot	23-Jan-2024
HR1976055	I.M. Parsons	05-Jan-2024

Membership Status Changed 2025

Deceased

Member No	Name	AuditDate
A2004014	J.R.M. De Freitas	13-Jan-2025
A2018012	R.T. Fynn	12-Jan-2025

Suspended due to no fee payment.

Member No	Name	AuditDate
A2021004	C.J. André	07-Jan-2025

SCIENTIA RERUM NAVALIUM

The South African Institute of Marine Engineers & Naval Architects

The Achievement of Arms – An Explanation

A symbolic ship's bow is superimposed on a rising sun, symbol of knowledge, power and wisdom. The ship is moving over the ocean towards the west, passing through a pair of callipers representing precision and measurement. The Arms, therefore, represent symbolically the joining together of all these attributes into one great amalgam of maritime science. The helm, torso and mantling are indicative of the standing of the Institute and represent chivalry and integrity. The crest, a lion and anchor, symbolises strength with humility. The supporters are a seal and dolphin, each of which is a mammal whose natural habitat is the sea. The dolphin's intelligence and the seal's versatility serve to amplify the symbolism of the Arms. The collars indicate the navies of the world who sail the waters of our country, ever tied to the sea. The mound represents the Republic of South Africa with the sea washing its coastline.

The motto "**Scientia Rerum Navalium**" on the Arms declares "to be skilled in the business of ships" which is what SAIMENA strives to achieve.

Scientia - to know, understand, perceive, have knowledge of, be skilled in ...

Rerum - a thing, object, matter, affair, business, event, fact, circumstance, occurrence, ...

Navalium - of ships, ship-, nautical, naval

Reformatted and Updated 10 September 2013 by KJ Watson

Educating Young, Female, Sea Cadets On Careers In Science, Technology, Engineering & Mathematics (STEM) - *#1MILLIONGIRLSINSTEM*

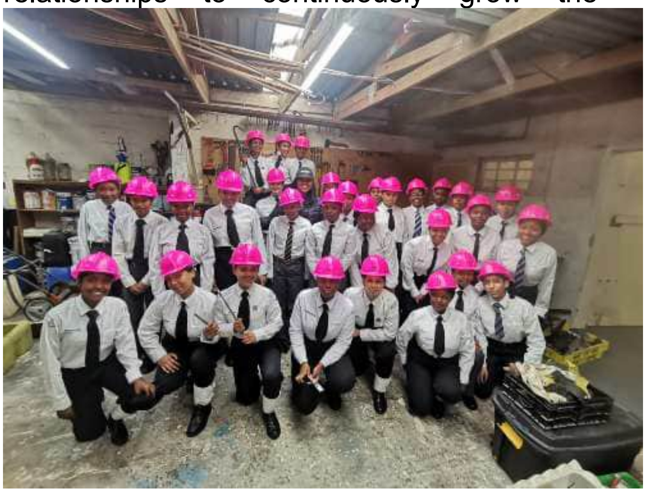
By Masego Mosupye

"Globally, women with qualifications in science, technology, engineering and mathematics (STEM) are under-represented, and South Africa is no different. (Denise Mhlanga). In South Africa, less than 13% of women choose to study in STEM disciplines, with men accounting for up to 28% according to the Global Gender Report, 2021.

Various different organisations in South Africa have taken upon the task of educating young girls about STEM careers in an attempt to increase the numbers, and amongst these is the South African Women in Engineering (SA WomEng) Non-Profit organisation. SA WomEng is a multi-award winning social enterprise, developing high-skilled girls and women for the engineering and technology industries. Their core philosophy is the promotion of STEM, focusing on engineering and technology from primary school to industry. Part of their projects include the #1MillionGirlsInSTEM campaign, which is global campaign initiated in March 2017, to reach 1 Million girls (aged 13 – 18) through STEM education and awareness initiatives. This programme is in collaboration with UNESCO. The #1MillionGirlsInSTEM campaign is a key component of WomEng's efforts to meet the Sustainable Development Goals.▌

campaign

Ms Masego Mosupye, a Chemical Engineer, ex-Naval Officer and now ARMSCOR employee, is a SA WomEng #1MillionGirlsInSTEM ambassador and is using established new networks as well as relationships to continuously grow the



through initiatives in her community. She partnered up with Mrs Historina Hlanze, an Electrical Engineer, also ex-Naval Officer and now ROMANO SOLAR employee, to present various careers in STEM to 45 female sea cadets at TS Woltemade.

The girls were in Grades 6 to 12, between the ages of 12 – 18. The South African Sea Cadets are a Non-Profit organisation dedicated to training and preparing school-going boys and girls for a career in the Maritime Industry.

Ms Mosupye & Mrs Hlanze endeavour to continue with these educational presentations until a larger audience is reached and the knowledge is transferred such that the young girls receiving this education on STEM careers, actually use it to join the STEM fields and end up becoming ambassadors for STEM careers in the future.

BRAVO ZULU LADIES!

Corrosion Poem

Mighty ships upon the ocean
Suffer from severe corrosion,
Even those that stay at dockside
Are rapidly becoming oxide.
Alas, that piling in the sea
Is mostly Fe_2O_3.
And where the ocean meets the shore,
You'll find there's Fe_3O_4.
'Cause when the wind is salty and gusty,
Things are getting awful rusty.

We can measure, we can test it,
We can halt it or arrest it.
We can gather it and weight it,
We can coat it, we can spray it.
We examine and dissect it,
We cathodically protect it.
We can pick it up and drop it.
But heaven knows we'll never stop it!
So here's to rust, no doubt about it,
Most of us would starve without it.

Written in 1974 by Tom Watson

Lubricant Compatibility

(Presented at the "Reliability – The Role of Lubricants" Seminar presented by the Southern African Institute of Tribology (SAIT) on 05 April 2023)

The purpose of lubricants is to reduce friction and wear between surfaces in relative motion and to ensure a system functions as it was designed. Lubrication engineering consists of a vast number of study topics, one of them focussing on compatibility between different lubricants. Lubricants are classified into four categories, namely, solid, semi-solid, liquid and gas lubricants. The focus of this paper is on compatibility between semi-solid, i.e., greases, and liquid lubricants. Because grease compatibility is better established than liquid compatibility, a short description is given on grease compatibility followed by a more detailed explanation of liquid lubricants in the rest of the paper.

Greases consist of mainly three components: liquid base oil (80 – 90%), thickener (8 – 15%) and additive package (2-5%). The thickener determines the basic characteristics of the grease, the base oil the viscosity and the additives are selected to enhance the performance of the grease in specific applications.

Grease incompatibility exists primarily between thickeners but incompatibility may also exist between different base oils and additives. Greases with polyurea as a thickener is a special case, where they consist of a variety of different compositions. Industry charts like Figure 1 are made to illustrate the compatibility between thickeners but may not always be 100% accurate. Therefore, it is recommended to always conduct testing before mixing different greases. ASTM 6185 – Standard Practice for Evaluating Compatibility of Binary Mixtures of Lubricating Greases was developed to provide guidance on compatibility testing where three performance characteristics, among other, are focussed on, namely, dropping point, mechanical stability and consistency.

Legend: ● Compatible; ▲ Borderline Compatible; ■ Incompatible

	Aluminum Complex	Barium	Calcium	Calcium 12-Hydroxy	Calcium Complex	Clay	Lithium	Lithium 12-Hydroxy	Lithium Complex	Polyurea*	Sodium	Calcium Sulphonate	Silica
Aluminum Complex	\	■	■	●	■	■	■	■	●	■	■	■	●
Barium	■	\	■	●	■	■	■	■	■	■	■	▲	●
Calcium	■	■	\	●	■	●	●	▲	●	■	■	N/A	N/A
Calcium 12-Hydroxy	●	●	●	\	▲	●	●	●	●	■	■	N/A	N/A
Calcium Complex	■	■	■	▲	\	■	■	■	●	●	■	●	■
Clay (Bentone)	■	■	●	●	■	\	■	■	■	■	■	■	●
Lithium	■	■	●	●	■	■	\	●	●	■	■	●	●
Lithium 12-Hydroxy	■	■	▲	●	■	■	●	\	●	■	■	●	N/A
Lithium Complex	●	■	●	●	●	■	●	●	\	■	■	●	●
Polyurea*	■	■	■	■	●	■	■	■	■	*	■	■	■
Sodium	■	■	■	■	■	■	■	■	■	■	\	■	■
Calcium Sulphonate	■	▲	N/A	N/A	●	■	●	●	●	■	■	\	N/A
Silica	●	●	N/A	N/A	■	●	●	N/A	●	■	■	N/A	\

* Not all polyurea greases are mutually compatible

Figure: Grease Compatibility Chart

Why would the compatibility of lubricants need to be tested? Several reasons include:

- Current products are out of stock and alternative products are immediately available.
- A product is discontinued.
- Better system performance is desired.
- A change to a greener or safer product is required.
- Suppliers have changed.
- Costs need to be saved.

It often happens that due to logistic supply challenges the incorrect oil is delivered. One can send the oil back and demand the correct oil be delivered but if there are severe time constraints, like a ship needing to sail within a day or two, there will not be enough time to replace the incorrect oil. This article looks at if the delivered oil can still be used and which properties to look out for to ensure that the delivered oil is compatible and/or interchangeable with the oil in use. The scenario described in this paper is a rule of thumb method to remedy it as best possible if presented with limited options.

When the incorrect oil is delivered, one should immediately question the quality and suitability of the oil. There are many “snake oil” suppliers, just waiting to supply you with their specially formulated universal multipurpose oil suitable for gearboxes, engines, hydraulics and turbines. There are many factors that can influence the quality of the oil. Some of these include:

- Incorrect formulation and blending.
- Contamination during manufacturing.
- Contamination during storage and distribution.
- Out of date stock.
- Mislabelling.

It is important to do some initial quality control. A simple way of doing this is compiling checklists with specific questions that include:

- Is the delivery on time?
- Is the lubricant delivered in the correct way?
- What is the condition of the packaging?
- Is it delivered at the correct location?
- What is the batch number?
- What are the oil manufacturer details?
- Is the oil from a reputable supplier?
- What are the recorded blend dates? This is an indication of shelf life.
- Where is the lubricant filling location? Ask the delivery person where the product came from and if the fill point is known.
- Has there been any intermediate storage facilities?
- What are the conditions of the blending and storage locations?
- Is a Certificate Of Analysis provided?
- What is the performance specification?
- Estimate product integrity by checking for any obvious signs of contamination.

If satisfied by the above information, it is advised to move onto compatibility testing and oil analysis. Compatibility of oil means that when oils are mixed, their components will not chemically react with each other. Fluids and oils that are either designed to be mixed, or may be mixed with no harmful effects are referred to as compatible. Those that cannot be mixed without potential problems are termed incompatible. It is essential to not only look at the compatibility of the fluids with each other, but also within the system and the operating environment. Lubricant liquid incompatibility is classified according to the nature of the incompatibility:

- Loss in solubility and/or responsiveness of the additives due to mixing of base oils. This is typically the most common occurrence.
- Base oils chemically react with each other.
- Base oils can react with unknown additives from a different oil, forming unknown by-products.

- Additives in different oils react with each other, forming insoluble reaction products. Some common interactions include:
  - Dispersants with Extreme Pressure (EP) or anti-wear.
  - Corrosion inhibitors with EP or anti-wear.
  - Friction modifiers with EP additives.
  - Acidic and alkaline additives.
- Additives can neutralize each other or alter the performance of other additives.

Some of the system and operating environment incompatibility factors include:

- Metallurgy and seals within a system.
- Remaining sludge and sediment after a short volume oil change.
- System and environment operating conditions.
- Relevant lubricant properties for the specific application.
- The relative proportions of the two fluids.

The nature of the incompatibility will influence the speed at which harmful effects are formed. The degree of incompatibility can be minor, or hardly noticeable, or lead to catastrophic failure of equipment. The negative effects are then exacerbated by the previously mentioned factors. Some symptoms of incompatibility that can be expected are:

- Impaired film strength leading to increased wear, vibration and acoustic emission.
- Water demulsibility leading to emulsion formation if water is present.
- Colour changes.
- Air handling ability leading to formation of foam.
- Formation of insolubles leading to filter clogging and sediment.
- Premature base oil oxidation leading to acid and sludge formation.
- Sudden high particle count from additive precipitation and/or insolubles.
- Gelation of lubricants leading to filter clogging and lubricant starvation.
- Leakage due to viscosity changes.

In general, never assume two lubricants are compatible, regardless of the application. Before establishing compatibility, they should be tested before they are mixed. With engine lubricants it can be relatively safely assumed that the oils will be compatible, but the performance of the oil may be negatively influenced. Typically, the manufacturer and sometimes the supplier of the oil will be able to tell you (to a certain extent) which oils are compatible with the delivered oil, but depending on the criticality of the system, additional testing may be desired. There are two stages (often referred to tiers 1 and 2) to compatibility testing. The first test is used as a quick check to eliminate any additional testing and the second is performed to determine if any long term problems can be expected.

The first tests involves preparing binary mixtures of the lubricants with questionable compatibility. Mixtures such as 50:50, 95:5 and 5:95 are often used, but this can be modified to better match the target application. After at least 2 hours at an elevated temperature followed by cooling down for an additional two or more hours, which allows the base oil and additives to chemically and physically interact, the mixtures are ready to be inspected. If floc, sediment, clouding or discoloration develops from the mixtures, the lubricants are confirmed to be incompatible without further analysis needed. If this does not occur, then another tier of testing should be seriously considered.

At this stage one should consider the criticality of the machine and the risk of failure due to incorrect lubrication. When the risk is deemed low, then a rolling changeover is usually acceptable. It is also advised to increase the frequency of oil monitoring activities. Situations where there is a higher risk associated with a changeover are typically older equipment, complex and unknown additive packages and systems with higher duty and criticality and the need, therefore, exists to conduct additional testing.

A lubricant specification or Product Data Sheet can be used as the baseline for the tier two performance tests. Performance tests include a range of chemical, physical and performance characteristics tests. Conformation of Industry Performance Specifications like API, ACEA, SAE, etc. should also be confirmed. The stage 2 tests are shown in the tables below. These tests can become expensive, depending on how extensively they are performed.

Physical Properties	**Chemical Properties**	**Performance Characteristics**
Viscosity at 40°C and 100°C	Total Base Number (TBN)	Viscosity Stability
Viscosity Index	Total Acid Number (TAN)	Filterability
Low Temperature Performance	Sulphated Ash	Air-handling Ability
Pour Point	Elemental Analysis	Water Handling Ability
Volatility	Phosphorous Content	Demulsibility
Flash Point	Sulphur Content	Film Strength
Resistance to Shearing	Zinc Content	Oxidation Stability
Foaming Tendency	Calcium Content	Corrosion Suppression
Particle Count		Load Carrying Capacity
Colour		Seal Compatibility
		Metal Compatibility
		Sludge Handling Ability
		Deposit Formation
		Soot Handling Ability
		Oil Consumption

The selection of these tier two tests is largely driven by the critical performance needs in the target equipment. An important part of the test is also to determine the acceptable values or ranges for each property. Standardised test methods, although not necessarily applicable in the current scenario, can be used as guidelines for testing. Standards that are often used are:

- Federal Standard 791: Testing Method of Lubricants, Liquid Fuels and Related Products:
    - Method 3403.2: Compatibility of turbine lubricating oils.
    - Method 3430.2: Compatibility Characteristics of universal gear oil.
- ASTM D7155: Standard Practice for Evaluating Compatibility of Mixtures of Turbine Lubricating Oils.
- ASTM D7752: Standard Practice for Evaluating Compatibility of Mixtures of Hydraulic Fluids.

Should incompatibility be found between the lubricant mixtures only (not the equipment or operating conditions), a changeover usually can be successfully performed if special precautions are taken. A complete removal (not just the tanks or sump) of the current lubricant followed by the removal of sediment, sludge and varnish is needed. A displacement/flush lubricant (one that is compatible with the new lubricant) is then used to remove any residual oil. A low viscosity base oil is typically used and is discarded after the flush. Heating the displacement fluid and passing it through all internal fluid zones at high velocity gives the best results. The greater the risk, the more rigorous the drain and flushing should be.

A changeover is strongly discouraged if incompatibility is found between the new lubricant and the equipment or the operating environment. If a changeover is still unavoidable, seek other lubricant options to mitigate the risk and consequences. If equipment surfaces fail to clean completely, a chemical flush may be added to the displacement fluid. One disadvantage is that this cleaner fluid must be completely removed from the system before the final lubricant is introduced. This is typically done with yet another displacement fluid. After the final flush the new lubricant can be introduced, and it is recommended to increase the frequency of oil monitoring activities.

In reality, when faced with lubricant supply challenges, not all tests can be carried out. Prioritise the tests that are essential to lubricant performance and equipment reliability in the specific system. Tests that are essential are viscosity, viscosity index, oxidation stability, cleanliness, and water content. Consider tests that will reveal multiple data points like an elemental analysis or FTIR and/or tests that are easy to perform. As a rule of thumb, if the mixed oil chemistry is deemed acceptable with no drop out of additives and the manufacturers are ISO 9001 accredited, then you are more than likely to be OK with mixing the oils.

(Credit: Jacques de Klerk)

How a Classification Society could have saved the OceanGate Titan Submersible

Figure: OceanGate Titan

As widely reported at the time, on 18 June 2023 OceanGate's Titan submersible suffered a catastrophic implosion while conducting a dive to visit the RMS Titanic. Sadly, all passengers lost their lives, but, fortunately, the implosion happened so fast that none of them would have been aware of the implosion or felt any pain. Today, the casualty report by the US Coast Guard Board of Investigation for this incident remains a work in progress and the incident reportedly remains under investigation. As the submersible was on the forefront of innovation, simultaneously incredibly well designed and making deep sea dives commercially affordable to the public, six months after the horrible event, one is still left asking: how could this have happened?

THE VESSEL

The following features of the vessel has been made public:

- It was 6.7m long with a beam of 2.8m and height of 2.5m.
- It had an endurance of 4 days.
- Its max speed was 3 knots.
- It was rated to a test depth of 4000m. (As the Titanic's remains are situated at approximately 3800m, we know that the submersible was still within the stated depth design parameters.)
- The vessel was not classed. (Classing it would have made the design and manufacturing processes longer and increased the costs to build the vessel.)
- It was constructed of a carbon fibre reinforced cylindrical shaped pressure hull fitted with titanium flanges on either side onto which titanium domes were fitted.
- The forward dome was fitted with an acrylic port hole.

Even though the science of composites in various marine applications is not fully understood yet, over time they have gained a good reputation due to their versatility, corrosion resistance and higher strength to weight ratio.

Figure: Main Components of Pressure Hull

BACKGROUND

In this article, general Classification Society rules and regulations will be used as an example of how safety standards are enforced when classing a vessel. The Titan submersible is classified as an autonomous submersible, meaning, the submersible requires a relevant support vessel during the mission but is not physically connected (e.g., by an umbilical). Apart from the Classification Society requirements, the International Maritime Organisation also stipulates design criteria for submersibles in MSC.Circ 981 dated 29 January 2001 – Guidelines for the Design, Construction and Operation of Passenger Submersible Craft. In general, all components of the submersible require design assessments, specifications, manufacturing assessments, testing and surveys. The manufacturing facility itself needs to be certified along with all materials used in the submersible. The Society also requires maintenance data, operating manuals, operating parameters, and all data from previous surveys. These measures are used to ensure that the vessel is constructed and operates safely, is maintained properly and performs as it was designed to perform.

Before looking at the specifics of the Classification Society, let's take a quick look at the physics of an implosion. There are three depths used to define the operating range of a submersible:

1. The Nominal Diving Depth
   The depth at which the submersible has unrestricted operational capabilities.
2. The Test Depth
   The depth at which equipment is tested after being repaired or to rate equipment.
3. The Collapse Diving Depth.
   The depth at which the external pressure overcomes the strength of the pressure hull.

Each depth has an associated safety factor for the hull and equipment. For the Titan with a nominal diving pressure of more than 60bar, the test diving depth safety factor is 1.20 and the collapse diving depth safety factor is 1.73. At the depth of the Titanic, the pressure from the water was approximately 380 bar (38 MPa). This value is lower than the typical static compressive yield strength of titanium, acrylic and carbon fibre composites (dependent on the lay-up). While the vessel was designed to withstand the water pressure's static forces, it went through loading cycles and extreme temperature changes, which may not only have caused a change in material performance, but volumetric expansion and contraction, all of which may have contributed to increased stresses and ultimately to mechanical fatigue failure. Mechanical fatigue of materials is the initiation and propagation of cracks due to cyclic loading. Once a fatigue crack has initiated, it will grow with each loading cycle until it reaches a critical size. Once the stress in the crack exceeds the fracture toughness of the material, it will rapidly propagate, leading to catastrophic failure of the material. The crack growth is dependent on the stress range during the loading cycles, where higher stresses lead to a shorter life. Fatigue is influenced by factors such as temperature, surface finish and material microstructure and is an irreversible type of damage. When a vessel reaches its collapse diving depth, the external pressure overcomes the strength of the vessel's structure, causing it to fail catastrophically and implode. This is known as critical buckling pressure. During an implosion, the boundaries of the structure and surrounding water are accelerated to high velocities and stop suddenly once the collapse is completed. This sudden change in momentum releases a pressure wave into the surrounding fluid which can have the potential to damage nearby structures. An initial underpressure develops as the implodable volume is reduced, a small sharp peak corresponding to the wall-to-wall contact and then a large positive pressure peak resulting from the change in momentum of the surrounding fluid. There are many speculated reasons why the Titan submersible may have failed. This article focuses on three possible structural failures which could have been prevented if the vessel had been classed. These areas include the failure of the following:

1. Acrylic port hole fitted on the forward titanium dome.
2. The interface between the carbon fibre pressure hull and titanium flanges.
3. The carbon fibre pressure hull itself.

ACRYLIC PORT HOLE

Acrylic plastic belongs to the amorphous thermoplastic polymer group and is commonly known as plexiglass or Perspex. This material is lightweight and has high impact resistance, durability, optical clarity and dimensional stability. It responds well to adhesives and, comparative to other plastics, is less prone to shrinkage; however, due to its relatively brittle nature, it is prone to stress cracking and fatigue. It has a tensile strength range of approximately 65 to 85 MPa. It is a versatile material with many uses and is widely used in the marine environment. The forward titanium hemisphere of the submersible was fitted with a conical shaped acrylic port hole with a diameter of 380mm and thickness of 180mm. A retaining ring and adhesive were used to secure it in place. The acrylic window was formally rated to a depth of only 1300m. According to Rush, the window would protrude into the vessel by about 20mm due the water pressure. In footage of salvaged debris, the port hole window is missing from the forward hemisphere, which may offer a clue as to what happened. Some industry experts claim that, due to the pressure hull failing and squeezing the two hemispheres together, the window was forced out of its cavity. According to Class requirements, the pressure hull windows should have been pressure tested after installation or individually to a pressure of 1.5 times the nominal diving depth for 1 hour but not more than 4 hours. This means that the windows should have been rated to approximately 6000m depth. After the pressure test, the windows should not exhibit scratches, cracks or permanent deformation. Non-destructive methods like x-ray and ultrasonic testing could have determined if there were any failures in the material. Non-destructive testing is required after each dive to monitor the initiation and propagation of cracks. As with any material, when being stressed this much, crack monitoring is essential to prevent failure.

Figure: Acrylic Port Hole During Manufacture

PRESSURE HULL AND TITANIUM FLANGE INTERFACE

OceanGate used epoxy adhesives to bond titanium flanges to the carbon fibre pressure hull. Adhesion is the bonding of dissimilar materials, where surface preparation and method of application are essential in the success of the bond. The adhesive bond formed between the flanges and the pressure hull is classified as a rigid adhesive bond, meaning it is a high strength bond with high stiffness. The strength of the joint is dependent on factors such as the joint geometry, the loading on the joint and the materials used in the joint. Application specific information for adhesives is often not readily available and requires individual research. Adhesive bond performance due to change in temperature, change in water salinity and cyclic loading could have assisted in ensuring the bond integrity holds during repeated dives. Class requires that various properties of the joint be tested before being approved for an application. Some of these properties, among many, include the tensile lap-shear strength, long duration lap-shear strength, tensile testing, glass transition temperature and dimensional stability. Only type approved adhesives may be used for bonding and they may not have any negative effects on the materials being joined. EN 1465 is a common standard used for testing adhesive performance properties. Three main factors could have contributed to failure of the Titan's bond. Firstly, it is speculated that an insufficient amount of adhesive was used. In manufacturing videos by OceanGate (the website is currently offline), no surplus adhesive is visible when the flanges and the pressure hull are fitted together. Some say that this is an indication of insufficient adhesive. A second factor is the difference in thermal expansion rates of carbon fibre compared to titanium, with titanium having a rate approximately 4 to 5 times higher. The different rates would have warped the geometry of the adhesive causing additional stresses as decreasing temperature combined with increasing pressure was applied. Thirdly, the physical ageing of the adhesive could have influenced the mechanical strength of the bond. Ageing is the weakening of the material over time due to temperature changes, extreme pressures and the presence of seawater.

Figure: Titanium Flange Being Fitted to Carbon Fibre Hull

Figure: Flange Fitted to Pressure Hull

PRESSURE HULL

The pressure hull was formed by a process known as filament winding on a mandrel. Alternating layers of prepreg carbon fibre/epoxy unidirectional fabrics in the axial direction with wet winding of carbon fibre/epoxy in the hoop direction. The hull consisted of 480 plies of carbon fibre and had a total thickness of about 5 inches. The pressure hull was made on a mandrel and bonded to titanium end flanges. There is speculation that the carbon fibre was bought from Boeing and was past its shelf life. This may have had an influence on the strength and performance of the material. Additionally, Oceangate did not use an autoclave but instead used vacuum bagging to apply pressure to the laminate. Autoclave produces a larger vacuum to get rid of air pockets and resin rich pockets and applies greater pressure to get denser products.

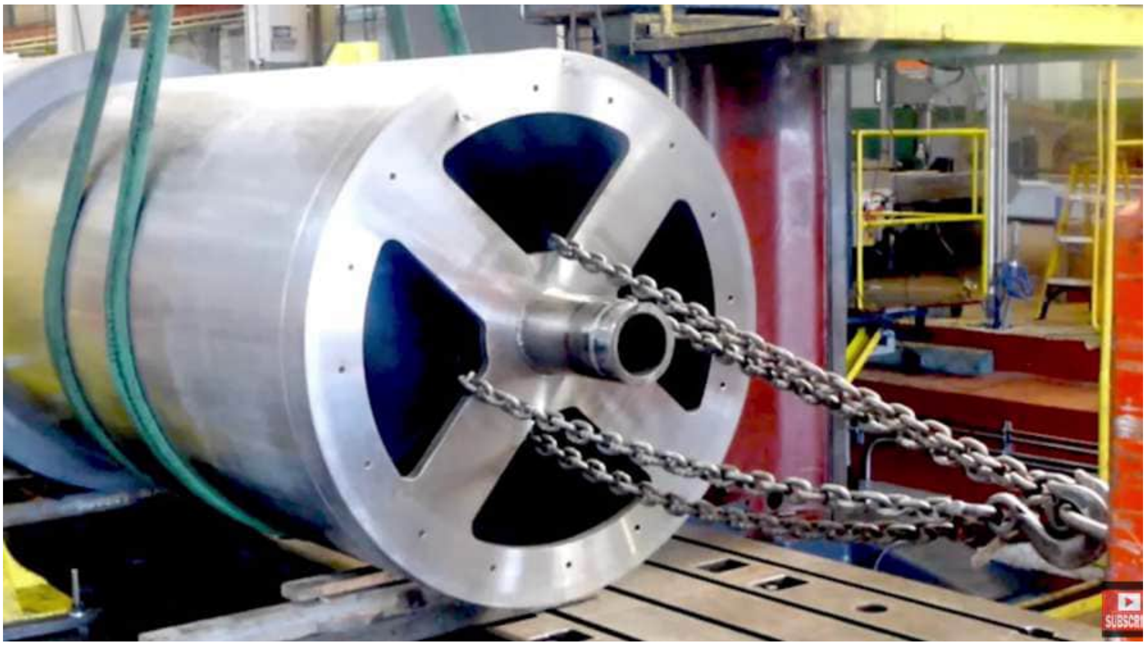


Figure: Mandrel Used to Shape Pressure Hull

The shape of the hull consists of two hemispheres and a long composite tube. When looking at a sphere, the pressure is distributed evenly over the surface of the sphere, but when elongated like the Titan, forces from each side of the pressure hull push inwards. This produces a compression force on the composite tube. The way in which the composite fibres are arranged did not provide for much strength in the longitudinal direction and the majority of the compressive force was carried by the epoxy resin matrix. In general, composites perform better in tension and not in compression. The compression of the end caps and inwards bending of the centre of the tube may have led to buckling and catastrophic failure. When compressing the composite, the force directions tend to promote delamination of the fibre layers, weakening the composite structure. This may have been the crackling sound heard when going below certain depths.

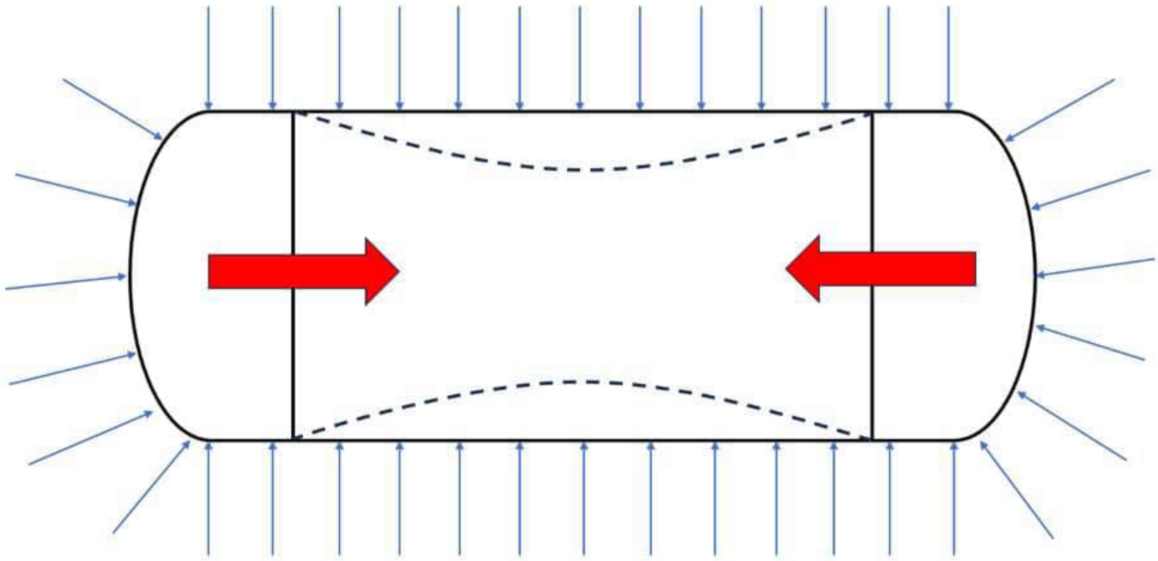


Figure: Pressure Distribution on Pressure Hull

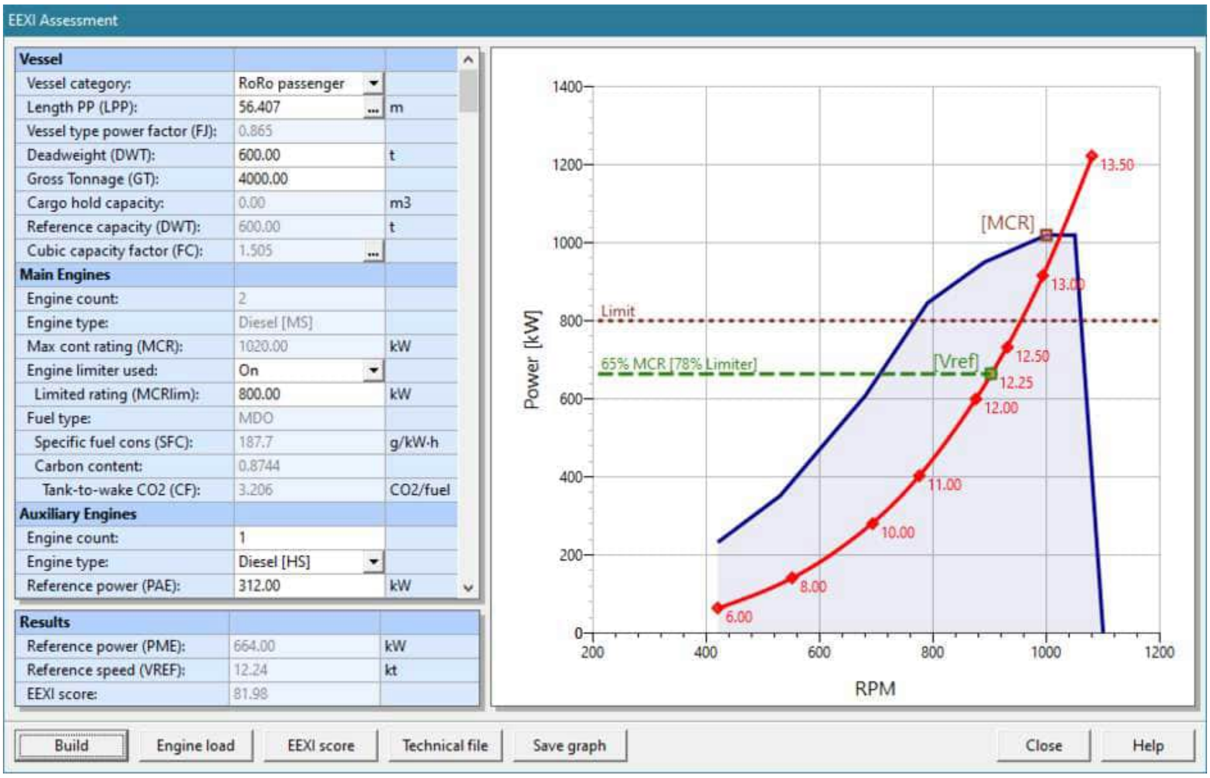
Class requires the tensile testing of the composite fibres and the tensile, compressive and flexural testing of the composite laminate. The testing regime includes unidirectional, biaxial, triaxial and quadriaxial testing and the minimum tensile strength values ranges from 1125 MPa to 500 MPa. The minimum compressive strength values range from 750 MPa to 335 MPa and the minimum flexural strength ranges from 900 MPa to 365 MPa. This testing should be done as part of the design analysis before vessel manufacture. After manufacture, the pressure hull should be pressure tested and inspected for leaks, deformations, cracks and delamination. Non-destructive testing methods are used for this purpose. The hull needs to be inspected regularly and tested with non-destructive testing to monitor for any cracks, delamination or deformation.

CONCLUSION

It is likely that the use of expertise and services of a Classification Society could have prevented the failure of the OceanGate Titan. It is undeniable that The Society could have made a significant impact in the design of the vessel and the manufacturing methods used and could have performed surveys to monitor the initiation and propagation of cracks. Unfortunately, fatigue is a type of failure that often remains hidden until catastrophic failure occurs. While a material may withstand a few loading cycles, one cannot know with any degree of certainty how many cycles it can withstand without closely monitoring the condition of the material. It is therefore essential that designers of vessels prioritise safety and ensure the necessary safety standards can be maintained through the vessel’s lifetime. The decision to rush or skip necessary design steps can cost lives.

(Credit: Jacques de Klerk)

The "KISS Principle" and Managing, Measuring Ship Emissions



Don MacPherson, HydroComp's long-tenured Technical Director, discusses the impacts of tightening emissions regulations, with insights on maximizing new vessel designs and refits.

Don, maritime has been in the crosshairs of regulators to reduce emissions. What do you see as the top new regulatory issues that are impacting ship and boat design, and owners, today?

What I'm seeing may be a bit of a contrarian stance and perspective. We've had an opportunity as a solution provider for many years to participate in a number of regulatory working groups for emissions in a broader sense. Both the greenhouse gas emission side, but also in the emerging aspects of underwater radiated noise. And I've seen some things that make me question objectives and motivations, not that the people involved are not well intended, certainly they're intelligent.

What, exactly do you mean?

There seems to be a tendency to focus on a methodology; I would use the term orthodoxy in some cases, but that might not be fair in this particular instance. They're focusing on how to do compliance, rather than trying to achieve broad compliance with simpler methods; for example, the EEXI calculations that are prevalent right now. Those are a pretty tightly controlled set of calculations through the various class agencies, prescribing a calculation approach using specific types of CFD calculation. The people providing the calculations have to show a competency through experience and validation calculations; that is technically valid, I understand the objectives of that. They want to make sure that everything is appropriate and in a comparative way across the board; but it's unnecessarily complicated. The lower limit of the bandwidth of companies that are going to have to consider this [are for vessels] as small as 400 gross tons, and that's not a very big ship. We have one company we work with, a big international bulk carrier company, with four ships that are exactly the same: same hull; same propulsion plants; same missions. They have one set of calculations to do for that particular ship group. But a small company running one ship has to do exactly the same level of effort, and it's an onerous task. There are, in my opinion, simpler methodologies using reduced order methods that achieve the same end. They're grounded in empirical testing and they fulfil the same objectives. For years, I've personally questioned the merits and the appropriateness of class societies developing the regulations themselves, and also providing services to fulfil those regulations. I know there are firewalls between the different groups and it's not a big problem, but the unnecessary complicatedness of the EEXI calculations speaks to maybe there's a simpler way to achieve that. And if what you're after is broad compliance, you want to make things as easy as possible.

At the outset you mentioned underwater noise. What's Hydrocomp's involvement in that area?

We've been working with a couple international groups on formally developing compliance regulations for underwater radiated noise. There are people on the regulatory side, people in the biological sciences side, and then there are engineers and naval architects like myself. For whatever reason, this group is hung up on empirical testing as the way to fulfil compliance, as opposed to what I would term rules-based compliance. I understand how they get there, because noise has always been tested, but interior noise testing for human response is very different than broad propagating radiated noise of a variety of different biological receptors. All the different marine mammals and sea life that are going to be affected by a ship's radiated noise. It's not the same thing. You can take a pelican case with equipment and you can bring it to any ship and do interior testing functionally. Completely appropriate to do that as a test-base system. The reverse is true for underwater radiated noise, where you have remote test facilities, which are expensive and are not common. Each facility is unique, so how do you calibrate everything to have a fair playing field. There's a whole host of reasons why this has greater uncertainty in the test. Because you have computations for correcting reception, which is what you actually record with the transducers back to a common source level. So what you're looking for are sound pressure levels at the source. Because that's the only common place that you can establish a benchmark that you can then establish a compliance regulation against. My thinking is that a rules-based approach – similar to how classification societies use rules for a propeller blade strength, or structural properties of a ship, or even damage stability calculations; we don't test a ship to damage in order to determine whether it's going to be safe or not. We use a rules- or a calculations-based approach, and I would propose for underwater radiated noise that is going to be the way to achieve the greatest compliance. They say that 80% of the cost of a ship is determined in the first five to 10% of the work. Which makes sense because you lock in so many things about whole geometry, propulsion options, at the outset. All of the characteristics of a ship are locked in during that initial design, and if we can include underwater radiated noise, greenhouse gas emissions and those sorts of things early in the design process, we are going to achieve broader international compliance than we could with testing. It's going to be faster, it's going to be cheaper, and ultimately, it's going to be more fair, collectively.

With some of the testing that is being proposed, what they're saying is that we're not going to bring everybody down to a noise level. What we're going to initially propose is that all ships get quieter by a certain decibel, a certain sound pressure level.

That's totally unfair because you have companies that are already well entrenched in a culture of sustainability, with an interest in creating quiet ships. And so now you're going to ask them to get even quieter, which is much more difficult to do. It's really easy to make a noisy ship quiet. It's not easy to make a quiet ship quieter without really extensive energy saving devices or flow manipulation devices.

So how is HydroComp a part of that emission reduction discussion?

Principally through our NavCad software tool, [with users] from small surface vessels, UV companies to the largest merchant shipbuilders, designers, operators. With NavCad you have a variety of different abilities to answer those 'what if' questions as a part of this hydrodynamic and propulsion system simulation. We view everything here at HydroComp as a system problem first, and the system is a vessel propulsor drive system where you have interrelated aspects of performance between the vessel and the propulsor. This could be a propeller or water jet surface drive or cycloidal drive. Then you have relationships up the drive line from the propulsor to the prime mover, which could be a diesel engine, a gasoline engine, electric motor of a variety of different types.

And then you have to provide an energy source, an energy source that might be liquid in terms of a fuel that has a certain heating value and densities associated with it. Or it might be an electric motor amperage demand where you're looking at trying to establish a battery budget or what you have to do in order to provide for recharging at different locations if it's a ferry. What NavCad can provide is the ability to look at different 'what if' scenarios early in the design stage, where you're going to get the greatest bang for your buck in achieving the best outcomes. Early on you may have opportunities where slight changes in whole geometry can achieve significant savings in resistance, savings that extend through thrust demand and up the power train into fuel consumption and GHG emissions. And NavCad takes you all the way through to that GHG production predictions and estimates of what you're going to be able to see. That can then lead to very interesting discussions early on because it's a good way to communicate to stakeholders, and you don't have to have a special PhD or advanced degree to run those calculations.

I understand the philosophy of making those critical design decisions early in the process, because as the design and construction progress, it gets exponentially more expensive to change. How common is it for ship owners and builders to embrace that notion?

Great question and a tough one to answer because you can never be in a customer's head and really understand their motivation. But a couple truths have become clear over the years. One, if it's not regulated, it's an option. If it's an option, there has to be some personal or corporate motivation to fulfil that. I'm not a big believer in altruism. People do things altruistically to feel good, and a lot of people feel good by investing in the future. My parents were both public school teachers, and they are wired that way. Certain companies are going to be wired that way; doing things because they view it as the right thing to do as opposed to it's the most profitable thing to do. Now, to be fair, sometimes the right thing to do also is the profitable thing to do. But when you talk about really looking downstream, that's very difficult.

What specifically does HydroComp offer to help owners design and run their vessels with reduced emission reductions?

The biggest thing is in how NavCad, either as a purchased product or as a consulting and engineering service from HydroComp, can answer those early technical aspects of business questions. That's the biggest thing. Now, it can also be used for retrofit evaluations, which is something is interesting with EEXI is coming up. You can create a sea trial study and then you can begin to look at [different design elements] like engine limiters, propeller options, adding a bulbous bow. As we get onto component optimization, we have our prop elements tool for optimized propeller design, PropCad, which is what our manufacturers would use for the design and construction of propellers. And then a sistercompany that Jill Aarons launched a few years back with Adam Kaplan, our propeller tools specialist in the house, is an inspection tool called TruProp. That can really help for smaller propeller, the motor yacht work community to really begin to dial in higher classes of propeller tolerance, which can lead to a little emissions improvement too. And everything you can do to make a propeller more precise will help with underwater radiated noise.

What kind of results for mission reductions can a typical client expect with the solutions that you propose?

That's another tough question to answer because so much of that relies on the culture of the people driving the ships. A number of years ago, we were involved in the development of the software side of what's functionally a cruise control for ships. It was a U.S. Coast Guard R&D Center project, and we found on their medium endurance cutters we could save 18% by allowing the system to drive the ship with a target speed; which was ridiculous. First of all, I didn't believe it. I had to do a separate engineering study to prove to myself that that was even possible. And it was. It's easy to find big gains if your ship is very poor to begin with, or if the operational culture is, "I've got three days to get there, but I want to go spend a couple days in port, so I'm going to run fast in order to do it." If your priority is to save fuel, it starts with the culture of the operation. But to answer your questions, I use a metric of 5%. Almost anything in hydrodynamics is limited to about a 5% improvement. And like I said (in discussing underwater radiated noise) the better you are, the less improvement you're going to be able to see. But it all starts with the culture. Maintenance is culture. Operation is culture. Making the system function in the best way it can, is culture. Giving you the best components of that system; that's design.

*This article was originally published in the August 2023 issue of *Maritime Reporter*, written by Greg Trauthwein.

(Credits: HydroComp, Inc.)

Fun with Propellers

The means to move vessels have come a long way. From sail and rowing vessels to steam powered paddle ships to diesel engine ships with propellers. When thinking of a propeller it is typically of a rotating hub with blades at a certain pitch that forms a helical spiral which exerts linear thrust in a working fluid. Now, imagine extending the blades and folding them back to from a closed loop, each blade essentially becoming a double blade. Propellers with these types of blades are known as toroidal propellers. The closed loop blades distribute the vortices created by the blades over the entire propeller instead of the blade tip, thereby reducing noise and improving blade efficiency.

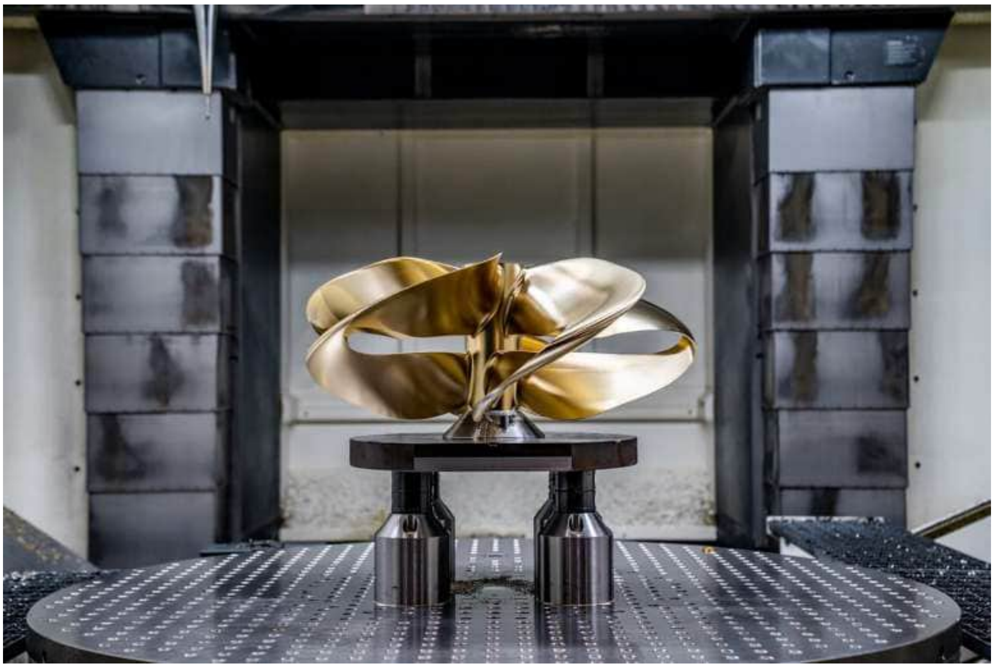


Figure: Toroidal Propeller

According to industry leaders in the application of toroidal propellers like Sharrow Marine, improvements up to 30% higher efficiency, noticeably less vibration, up to 50% more reverse thrust and greater ranges of operation are achievable. Below is a study conducted by Sharrow Marine indicating the improvements in efficiency over engine speed.

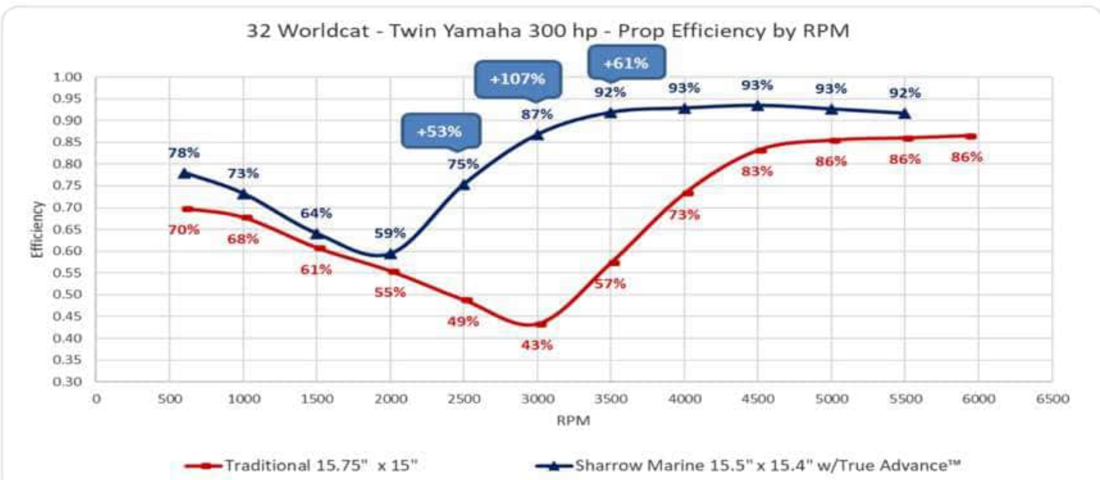


Figure: Efficiency Improvement of Toroidal Propeller

The shape of the propeller blade also has improved safety features such as reduced chances of propeller cutting or the propeller getting fouled. With all the improved features there are some disadvantages, with the major drawback being the complexity of manufacture. Currently, they are manufactured with CNC machining or 3D printing. This technology on a commercial scale is still relatively new and there are still many opportunities for product improvement, especially in manufacturing techniques. On the topic of 3D printing. One of the world leaders in testing, inspection and certification called Bureau Veritas (BV) has certified a prototype 3D printed hybrid manufactured propeller at the Port of Rotterdam's RAMLAB completed by Naval Group. The propeller is a three bladed "WAAMpeller" with a diameter of 2500 mm and was made with Nickel Aluminium Bronze using Wire Arc Additive Manufacturing (WAAM). After the initial additive process, the propeller will be CNC milled at Autodesk's Advanced Manufacturing Facility in Birmingham. BV noted that material characterisation and mechanical testing has been an essential part of this project and ensuring that the material properties meet the demands of the application. The first propellers were fitted to and successfully tested on a Damen Stan Tug 1606. The propeller is the currently the largest metal 3D printed propeller and the first one made using additive manufacturing technology.

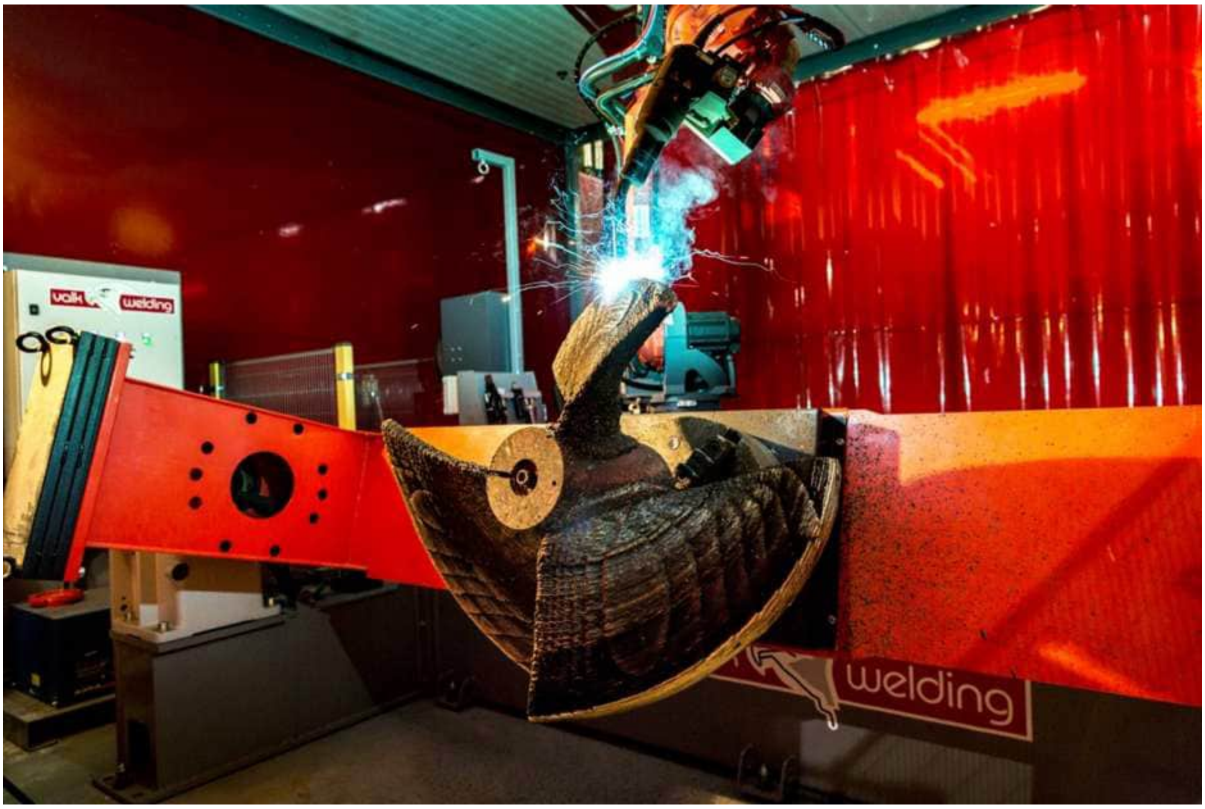


Figure: In the Process of Being Manufactured

Figure: Unveiling of the Finished Propellers

(Credits: Sharrow Marine and Bureau Veritas)

Cape Size Vessels: Some Experiences of a Marine Engineer

Typically, a “CAPE SIZE VESSEL” is a very large bulk carrier in the order of above 150,000 DWT Greater than 270m in length a beam of 45m and draft about 18m normally has nine cargo holds. The vessels were too large to passage the Suez and Panama Canals and had to round the Cape of Good Hope thus the name Cape Size. Acting as an independent engineer surveyor the undersigned worked on many of these vessels and the following are the experiences and findings on three vessels that encountered catastrophic incidents. The findings are my personal viewpoints and opinions may not concur with other party conclusions. Due to legal constraints the vessels will not be named.

Vessel 1

This vessel was on a ballast voyage from Spain to South America in 1999 when an incident occurred while changing ballast water resulting in the flooding of the engine room. The undersigned was contracted by the owners to act as superintendent to restore the engine room. The vessel was towed to Las Palmas where repairs were carried out. Ballast water regulations require that upon departure to deep sea after taking on board ballast water in a port the water must be changed in order to prevent the spreading of marine organisms around the world. The Chief Officer was performing this operation at the ballast control station when the engine room bilges started to fill. The source of the water ingress could not be found, and the main engine had to be stopped while flooding continued. When flooding started the master contacted management at head office who had recently initiated an emergency response centre as required by the very new ISM code. The head office team were in fear of the vessel sinking and gave instructions to shut all sea valves suction and discharge. They also instructed the vessel to drop all the top side ballast tanks. This turned out to be a fatal error as the ballast water from top side tanks continued the flooding of the engine room well above the mean sea level. When we arrived on board the vessel in Las Palmas the vessel was drawing a draft of about six meters. On inspection of the engine room, it was found that the water level was at about the top plates or cylinder cover level. This was at about ten meter above keel. After pumping out the engine room it was discovered that two ten-inch cast steel valves connecting the bilge system to the ballast system had shattered and were the source of the flooding in the engine room. In hindsight a lot of the flooding could have been prevented by stopping all ballast operations stopping the main engine and shutting all sea valves. The main source of flooding was self-inflicted by dropping the top side tanks. While proceeding with the restoration of all mechanical and electrical equipment we were commissioned to find the cause of the flooding and what caused the bilge isolating valves to fail. The vessel had been in operation for about eight years, there was no stress or corrosion problems on the valves therefore it had to be a pressure problem and we suspected water hammer to be the cause. The ballast system was operated by 600mm main ballast pipe running down the duct keel. The ballast valves were controlled by Danfoss hydraulic actuators. We contacted Danfoss who advised that the rule of thumb for response time was one to two seconds per inch of diameter. We were dealing with 24-inch valves therefore a response time of 24 to 48 seconds. We grabbed the Danfoss instruction book and on the first page the response times were listed at new building at 1.8 to 3 seconds. Walla there was the problem. Water hammer of enormous proportions. A simple calculation showed that there was 58 ton of water flowing in the main ballast line and if stopped in under 3 seconds caused great force and pressure.

Vessel 2

This was a Greek owned vessel on completion of loading a cargo of iron ore at Saldanha Bay she was found to have a port list. Sounding of the ballast tanks revealed that No 2 P ballast tank contained water causing the list. Divers discovered a large crack in the hull plate at the aft end of No 2 P ballast tank. SAMSA surveyors declared the vessel unfit to go to sea in her fully loaded condition. The decision was made to discharge the cargo and send the vessel to a drydock in ballasted condition. The unloading of the cargo into smaller handy size vessels took about four months. This had huge implications on the export capability of the port of Saldanha Bay as the working berths were reduced from two to one. We were contracted to represent the cargo owners' interest at the drydocking of the vessel at Tuzla Shipyard Turkey. The vessel was found to have a severe indentation on the port side shell plate, extending from the fore peak tank through No 1 and No 2 ballast tanks and ending abruptly at the bulkhead of 2/3 ballast tank, where a severe transverse crack and rupture of the shell had occurred. The indentation was in the shape of a curve being forced into the ballast tanks slightly inboard of the turn of the bilge on the flat bottom. Longitudinal score marks were found in the indented plate down to bare steel. Internal condition of the scantlings was good and loss of strength due to corrosion wastage was discounted. We were refused access to logbooks documents or crew so determining the cause was difficult. The nature and extent of damage indicated the vessel had ridden over an object at speed and come to an abrupt stop. The previous voyages had been loaded iron ore at Port Headland Australia sailed passed the coast of Philippines to Shin Dago China where the cargo was discharged. Vessel sailed from China in ballast condition to Saldanha Bay for her next cargo of iron ore. Then the flooding occurred. About three years later we were given a copy of the deck logbook. It was recorded that while sailing passed the Philippines an upturned fishing vessel had been sighted. The vessel diverted from the passage plan to search for the fishing vessel in the hours of darkness. The fishing vessel was not found, it was reported to coast guard and the vessel continued voyage. We did some oceanographic research and found that the Philippines and surrounding waters contains a lot of volcanic peaks and outcrops may of which are not charted. We concluded that the vessel had ridden onto one of these outcrops at full speed which caused the indentation but no rupture of the shell. No water ingress occurred at this time although a crack may have been preset. During loading at Saldanha Bay the hull is places under variable stresses which caused the crack in No 2 P to rupture allowing the water ingress. We prepared for litigation at The High Court of Cape Town, one day before the hearing the matter was settled.

Vessel 3

This vessel loaded steam coal in Richards Bay August 2013 and sailed into extreme swell entering the harbour mouth. The vessel was on full ahead increasing in speed to over 8 knots on a heading of 110 degrees in the vicinity of buoys 1-2. The very heavy swell caused the vessel to pitch as the bow entered a trough, she heaved up over the next wave and the rudder struck the seabed with tremendous force. The steering gear was damaged and 2/3 of rudder broke off and fell onto seabed. Main Engine stopped due to propeller striking the seabed and speed immediately reduced. The propeller blades were bent in an aft direction. Without power and steerage, the vessel now drifted in a northeast direction beyond the breakwater out of the dredged entrance channel towards shallow water where she grounded forward. At the instant of the rudder impact and damage rupture to the hull occurred as No4 double bottom tank started filling (reducing buoyancy) and bulges on the deck plate aft of No 7 appeared. Three harbour tugs arrived but could not free the vessel from the shallow water. Seas from the extreme swell conditions were breaking over the forecastle and No1 hatch as the vessel was now broadside onto the incoming waves. The vessel continued to break up in this location. The vessel was abandoned the master being the last to leave. The port was closed immediately after the incident and was no reopened until the following morning when the swell had abated. Three days after the incident we boarded the vessel by helicopter to carry out investigations. By this time the aft machinery space had broken away from main hull and was afloat and attached to the hull at an angle of 35 degrees. The wave rider buoy located about 1 km off the breakwater had recorded swells in excess of 8m directly into the harbour entrance. This information is transmitted to Port control office and recorded by CSIR. No action was taken by port control to prevent this incident from occurring. It was extremely fortuitous that the vessel sunk outside the breakwater and not in the entrance channel as the port would have been closed for many months.

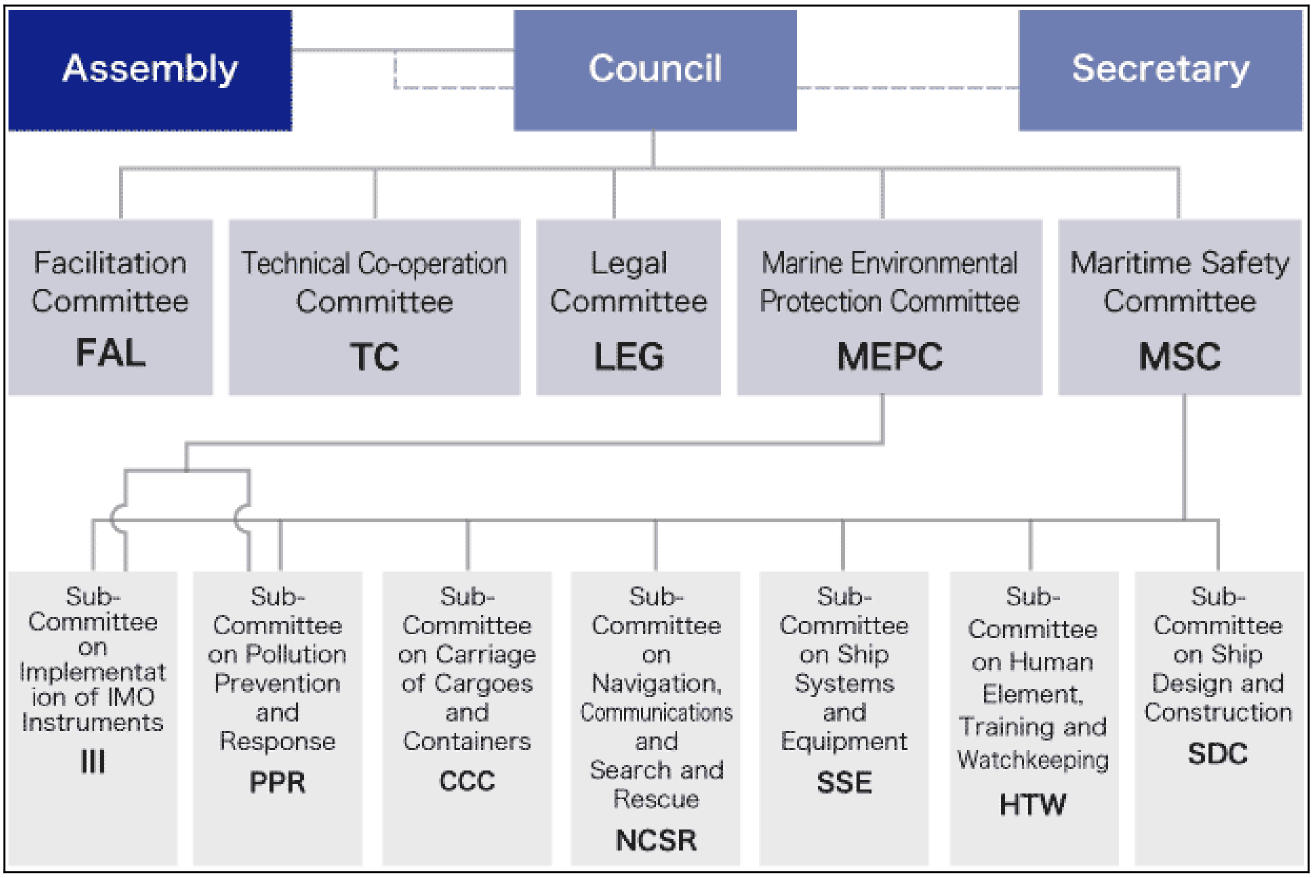
(Credit: Trevor Forbes)

The International Maritime Organization (IMO)

The International Maritime Organization (IMO) is a specialized international agency of the United Nations. The IMO's primary purpose is to ensure cooperation between Administrations with regards to all manners of technical instruments and conventions affecting international maritime trade, and to promote the safety of shipping, effective maritime operations, and the prevention of marine pollution by ships.

IMO, whose membership includes some 170 Member States and 110 participating NGOs, works constantly to establish, update and revised safety criteria for ship construction and equipment, technical requirements and limits for cargo loading, prevention of oil pollution, and emission of harmful substances and exhaust gas from the ships, environmental protection, maritime security, among other areas.

An overview of the IMO structure can be seen in the chart below. IMO is governed by the IMO Assembly and the IMO Council. Beneath the Council, there are five main Committees, including the Maritime Safety Committee, which addresses issues related to safety at sea, and the Marine Environment Protection Committee which addresses issues related to protection of the environment. In order to ensure effective operations, numerous sub-committees have been established which report to their parent committees and provide advice on technical matters.



IMO Structure

Assembly

The Assembly is the governing body of the IMO and consists of all of the member states and meets every two years. The Assembly determines the IMO's work plan and budget, as well as carrying our elections of new members and other organizational tasks.

Council

The IMO council consists of 40 Member States which serve a term of 2 years on the Council.

MSC (Maritime Safety Committee)

The MSC is composed of all the IMO Member States and meets three times over a two year span.
MSC is tasked with "considering any matter within the scope of the Organization concerned with aid to navigation, construction and equipment of vessels, manning from a safety standpoint, rules for the prevention of collisions, handling of dangerous cargoes, maritime safety procedures and requirements, hydrographic information, log-books and navigational records, marine casualty investigations, salvage and rescue and any other matters directly affecting maritime safety". Further information about the activities of MSC and its Sub-Committees are available at the link below.

MEPC (Marine Environment Protection Committee)

MEPC is composed of all the IMO Member States and meets three times over a two year span. MEPC is tasked with "considering the prevention and the control of pollution from ships and related rules." Further information about the activities of MEPC and its Sub-Committees is available at the link below.

Sub-Committee

Sub-Committees consist of all the IMO Member States and meet annually.
Each Sub-Committee carries out specialized discussions of on specific technical matters and then reports their findings to their parent committees (i.e. MSC and MEPC) for further action, for example the revision of conventions and other instruments.

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The Editor..