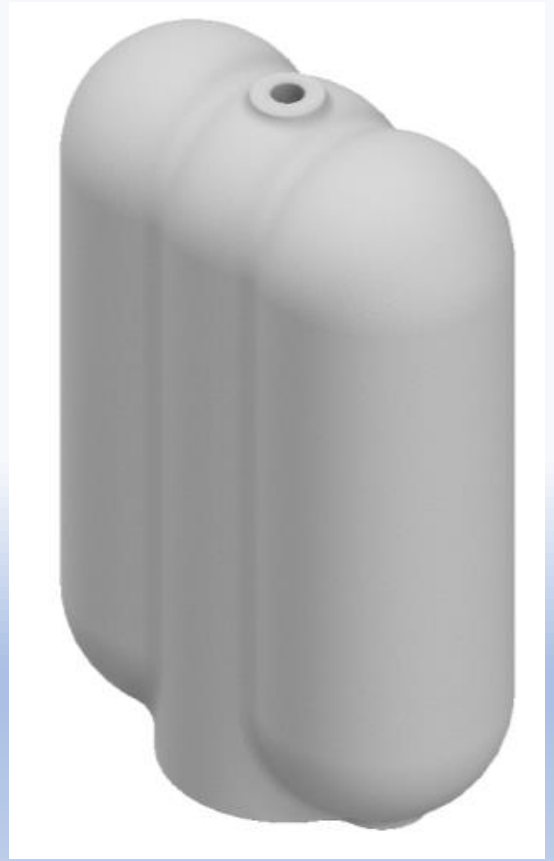
Hydra Tanks LLC Intro

- Unique cast Cylindrical Hybrid pressure vessel design
- Different from any other pressure vessel currently manufactured and marketed



- **MORE CAPACITY**
- **IMPROVED SAFETY**
- **BETTER ERGONOMICS**

Hydra™ Tank LLC

HISTORY OF ALUMINUM CYLINDERS

- Present manufacturing, technology, industrial, military, and aerospace efforts.
- Manufactured using a spin forming process
- Limited variety of materials
- Catalina Cylinders is one of the largest aluminum tank Manufactures
- Standard scuba cylinders are not LBB (Leak-Before-Burst) and do not have a definitive safe-life
  - Aluminum cylinders must be visually inspected every year and hydro-proof tested every five years
  - At current rates the cost of ownership in a 20 year period is more than 5 times the original purchase price
- Hybrid scuba tank would be LBB with a safe-life greater than 20,000 cycles
  - No need for annual inspections and quinquennial testing
  - Cost of ownership eliminated
- Additional markets available because of tank scalability
- Reuse of accessories with minor modifications

Hydra™ Tank LLC

ISSUES WITH EXISTING TANKS AND MANUFACTURING

- Spin forming Creates multiple vessel defects
  - Folding
  - Cracking
  - Reduction in mechanical properties
- Hydra Proofing requirements
  - Annual visual inspections
  - 5 year hydro proofing 30-80 dollars
- Ergonomics
  - Shape
  - Handling

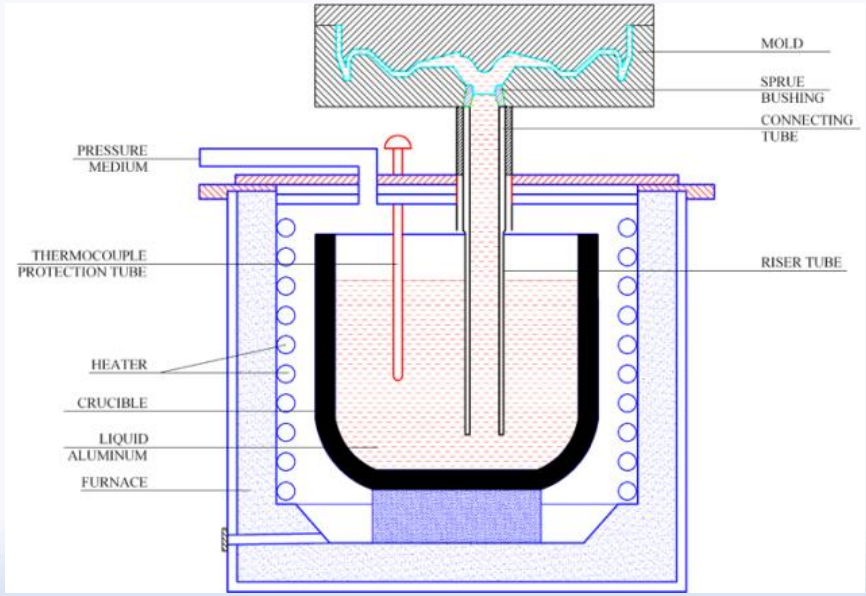
Spin Formed Tank

Actual casted Prototype of New Hydra Tank

Hydra™ Tank LLC

New Manufacturing Solution

- Casting could remove many of the existing engineering limitations and weaknesses
  - Enable new designs
  - Better materials and processes
- Vessels Result in:
  - Safer
  - More efficient
  - More ergonomic
  - Less expensive across this very broad market
- New design will demonstrate:
  - Better Pressure vessel
  - New Manufacturing methods
  - New Materials
  - Heat treatments and mechanical conditioning
  - Prove **Cylindrical Hybrid** vessel
    - Superior mechanical properties
    - Capacity
    - Improved safety



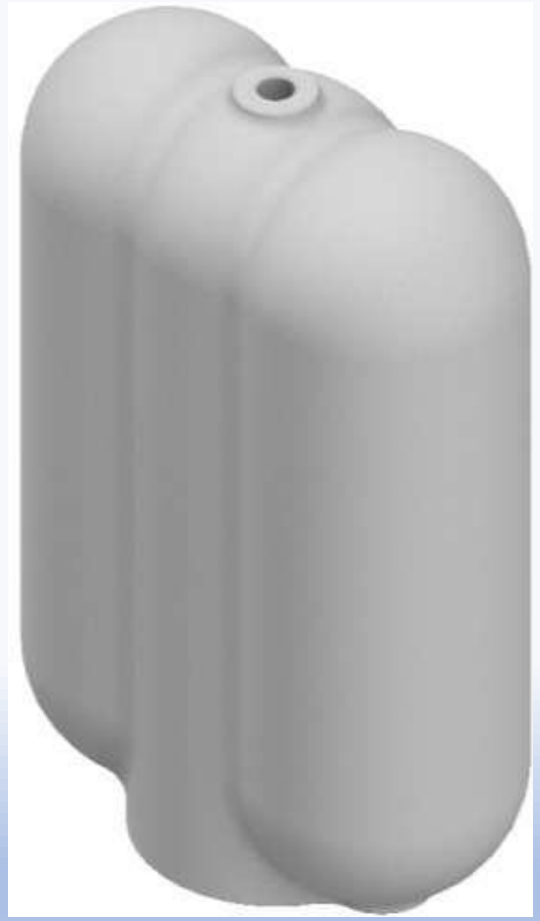
Hydra™ Tank LLC

The Patented Innovation

Few if any pressure vessels have ever been produced using cutting edge engineering, casting process and materials.

Casting could remove many of the existing engineering limitations and weaknesses, plus enable new designs, better materials and processes

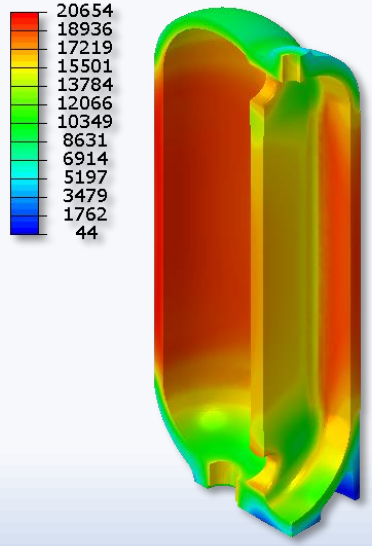
- Hybrid pressure vessel consists of a number of conjoined cylinders
- Manufactured using various methods
- Variety of materials can be used (bronze, ductile iron, stainless steel, aluminum, etc.



Hydra™ Tank LLC

Tank is Leak-Before -Burst/ Fail Safe

- Leak-Before-Burst (LBB)
  - Failsafe design methodology that ensures a detectable leak would occur before a catastrophic fracture
- Safe-life
  - Minimum number of pressure cycles expected before an undetectable flaw could develop into a leak
- Standard scuba cylinders are not LBB and do not have a definitive safe-life.
- Analyses were performed
  - (1) proof pressure
  - (2) operating pressure
  - (3) burst pressure as per Specification 3AL
- Failure analysis of Hydra Tank Hydra Tanks stresses are lower
- Exceptional material toughness and design
  - Well suited to autofrettage to improve the fatigue life



Hydra™ Tank LLC

Cylindrical Hybrid pressure vessel .vs. standard

Standard aluminum scuba cylinder:

7¼ inches in diameter

26 inches tall

weighs 32 pounds

capacity of 77 cubic feet of air

New Hydra Tank Cylindrical Hybrid:

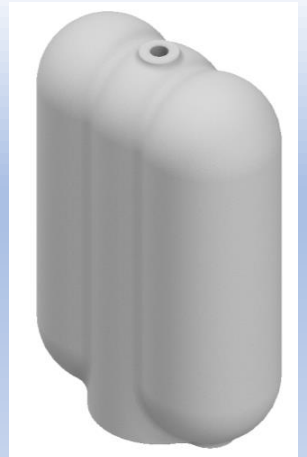
6 inches in diameter 12 x 18 inches

weighs 33 pounds

capacity of 95 cubic feet of air

Capacity is significantly better approximately 25%

Cylindrical Hybrid Scuba	
Height:	18 in
Width:	12 in
Diameter:	6 in
Weight:	33.2 lb
Volume:	695 in^3
Capacity:	90.0 ft^3
Pressure:	3442 psi



Cylindrical Hybrid Medical O2	
Height:	13.5 in
Width:	9 in
Diameter:	4.5 in
Weight:	9.6 lb
Volume:	335 in^3
Capacity:	31.4 ft^3
Pressure:	2215 psi

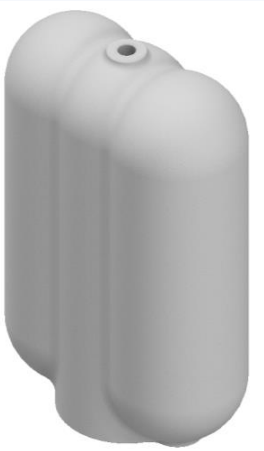
Hydra™ Tank LLC

THE DEVELOPMENT PHASE

- Preliminary designs have been evaluated using finite element analysis.
- Down select to a suitable aluminum alloy and casting process
- Promising alloy candidate found
- Proposed process is low pressure permanent mold disposable shell molded sand core
- Results were used to produce cast specimens representative of a production part, testing results are very good

Hydra™ Tank LLC

The Business Case



- Scuba Tanks
  - Sporting goods are wants not needs
  - Pricing flexibility to test the market
  - Scuba tanks are a logical market entry point
  - Marketing to trade shows, advertising, web sites and retailers
- Oxygen Tanks
  - Easy follow-on market in the medical field
  - Hydra Tanks' scalable design adaptable to multiple industries

Hydra™ Tank LLC

THE INDUSTRY MARKET

- **Medical Oxygen Cylinders**
- USD 8.30 billion in 2018 and expected to reach USD 14.41 billion by 2025 with the compound annual growth rate (CAGR) of 6.2% over the forecast period.
- **Industrial Gas Cylinders**
- USD 87.3 billion in 2019 and is expected to grow to reach USD 134.3 billion at a CAGR of 5.5% from 2020 to 2027
- **Carbon Dioxide Cylinders**
- USD 7.66 billion in 2019 and is expected to grow to USD 9.68 billion at a revenue-based CAGR of 3.4% from 2020 to 2027.
- **Scuba Diving Cylinders**
- $3.73 billion in 2017, and is expected to reach $5.11 billion by 2025, registering a CAGR of 4.1% from 2018 to 2025
- The demand for a pressure vessel with improved capacity, safety, and ergonomics is indisputable.

Hydra™ Tank LLC

NEXT STEPS TO MARKET

- Scuba tanks are more easily marketed
  - Magazines
  - Trade shows
  - Internet stores (Amazon) that sell direct to consumers
  - Safety ergonomics
  - Cost of ownership
  - Driver for customers to purchase hydra tanks
- For divers more air in a smaller package is significantly improved
- Existing equipment can be used with small adaptations
- BC manufacturing can be included in these adaptive or new designs
- Medical oxygen tanks
  - better ergonomics
  - improved safety and efficiency
  - No more dragging those long skinny tanks around on a little cart.
  - 4 inches in diameter 8 x 12 inches and weigh less than 8 pounds
- Leak before burst (LBB)
  - No continuing cost for annual inspections and hydra burst certification
- Success in these two multi-billion dollar
  - potential into adjacent markets

Hydra™ Tank LLC

Research & Development Goals

- Next Steps:
  - Complete process planning for casting, heat treatment, mechanical conditioning
  - Procure materials, tooling and molds
  - Build 100 scuba tanks
  - Section a number of tanks for metallurgical testing and verification
  - Perform mechanical testing
    - Burst tests
    - High cyclic testing
    - Damage tolerance testing
    - Safe life
    - Leak before burst demonstrations
  - Show compliance with DOT specifications/certifications

Hydra™ Tank LLC

THE TEAM

- **Kevin W. Richards:** BS, Mechanical Engineering
  - Utah State University, Logan, Utah
  - Manufacturing Emphasis, Math Minor
  - Kevin is the inventor, company founder, and patent holder. He is a designer and structural analyst with years of experience designing, analyzing, and testing pressure vessels of every description. He is currently serving as a voting member of *AIAA* (*American Institute of Aeronautics and Astronautics)* Aerospace Pressure Vessels CoS (Committee on Standards).
- **John Eldon Bott:** MS, Material Science
  - Brigham Young University, Provo, Utah
  - Eldon is a materials scientist/metallurgist with an incredibly in depth expertise in manufacturing and processing metals. He has years of experience in various industries including aerospace, nuclear, military, submarines, wind turbine generators, smelting oven design and research, and steel manufacturing at many different steel manufacturing companies throughout the US.
- **Matthew C. Walters:** PhD, Civil Engineering, Structures
  - University of Illinois at Urbana-Champaign
  - *Dissertation*: Domain-integral methods for computation of fracture-mechanics parameters in three-dimensional functionally-graded solids
  - Matt is a fracture mechanics expert that will enable us to produce a high pressure aluminum tank that is LLB and fail-safe, something that has never been done before. Matt's experience includes fatigue, fracture, and damage-tolerance analyses using NASGRO, FEA Crack, ABAQUS, and ANSYS, testing and assessment per ASTM E 399, E 647, E 1820, E 1921.
- **Steven G. Howard:** MS, Information Systems
  - Graduate School University, Phoenix
  - Steve is a computer scientist whose specialty is web services and website design. The perfect skill set needed to bring Cylindrical Hybrid tanks into the marketplace.
- **Eck Industries Inc.:** While not formally a member of our team we have searched a long time for a casting vendor that would be willing to take on a science project.

Hydra™ Tank LLC

Required Funding

ASTM-E-647 Fracture crack growth rate 3-6 specimens	**$10,000**
Westmoreland Engineering Support and Data Reduction around $590 per 9 specimens.	$590.00
Westmoreland is quoting stress corrosion cracking testing.	$375.00
Cyclic testing, proof testing, burst testing and 50 cal impact tests.	$5,000.00
American Metallurgical for EDS dot maps, micrographs, microhardness profiles (cross section and transverse).	$10,000.00
ek industries travel, Molds, 200 tanks for testing	$250,000.00
Department of Transportation	$25,000.00
Metallology	$30,000.00
PHD Analysist	$40,000.00
Design Engineer	$40,000.00
Casting Engineering	$35,000.00
Total	**$445,965**

Looking forward to the opportunity

During the past 60 plus years, pressure vessels have largely been manufactured using extrusion and spin formed ends or are rolled and welded with forged end domes.

This history has highlighted many failings of these last two popular manufacturing methods. Spin forming creates multiple defects including folding, cracking, and a reduction in mechanical properties. Many failures from extruded and spin formed tanks are well documented. Rolled and welded tanks also exhibit a myriad of safety and failure modes too numerous to detail in this report.

New Hydra Tank

Advantages include the very important improvements of safe life and leak-before-burst. The cast Cylindrical Hybrid pressure vessel also provides improved capacity, more compact size, markedly enhanced ergonomics and has a flat base allowing it to sit in a stationary, stable and unsupported configuration.

- **MORE CAPACITY**
- **IMPROVED SAFETY**
- **BETTER ERGONOMICS**

- Kevin Richards “Company founder, patent holder” kevin.Richards@hydratanks.com
- John Eldon Bott “Materials scientist/metallurgist” Eldon.bott@hydratanks.com
- Steven Howard “Computer Scientist”
- steven.howard@hydratanks.com

Oxygen Prototype

Hydra™ Tank LLC