MOTORAV – The Only Modern Aircraft Piston Engine with Extensive Magnesium Content

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75th Annual World Magnesium Conference
May 16-18, 2018 | New Orleans, Louisiana USA

PRESENTATION OUTLINE

1 – General Aviation
2 – MOTORAV and Rima Industrial
3 – Engine´s Main Components Design
4 – Innovation with Intensive use of Magnesium
5 – Status of the Engine Development

GENERAL AVIATION

Aircrafts used for non-commercial purposes or personal use

- Light Sport Aviation (LSA): Follows the ASTM F37 (less complex than FAA airworthiness standards)

GENERAL AVIATION

- Experimental Aviation: 51% Amateur – Built (more than 33.000 units licensed by FAA in the USA nowadays)
- Affordability (purchasing price and maintenance costs similar to premium cars)

- Freedom to commute faster specially in big countries like USA, Canada, Brazil, Australia and China

GENERAL AVIATION

100 HP Lycoming Aircraft Engine

100 HP Continental Aircraft Engine

- Lycoming and Continental aircraft engines are among the most popular Boxer Air Cooled Piston Engines on the market

GENERAL AVIATION

80 HP VW Engine Conversion for Aircraft Use

- The VW Beetle Engine concept fits well in the aviation philosophy that normally prefers air cooling over water cooling;
- However automotive engine conversions have some performance limitations;

MOTORAV AND RIMA INDUSTRIAL

- Rima Industrial operates a fully integrated magnesium plant in Brazil since 1981;
- Rima´s Strategy: Add value to its magnesium products;
- MOTORAV is a new step of Rima´s strategy;

MOTORAV AND RIMA INDUSTRIAL

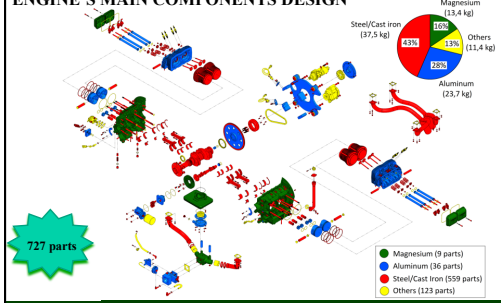
- In 2000 RIMA INDUSTRIAL became a die caster;
- In 2003 RIMA was nominated by VW Group as the OEM supplier of the Beetle air cooled engine cases for the replacement market worldwide;

- Engine Cases are die casted using the AS41 magnesium alloy and are fully machined and pre-assembled for direct use ;

MOTORAV AND RIMA INDUSTRIAL

- Several companies and individual customers have asked Rima to develop a new aircraft engine using the boxer Beetle engine platform;
- VW never showed any intention on developing an aeronautical power plant using the Beetle engine layout;
- In 2006 Rima created MOTORAV LTD in order to start a greenfield project using the basic VW Beetle engine layout to create an authentic born aircraft power plant;
- MOTORAV LTD assembled a strong team including engineers from different disciplines in Brazil, pilots and some of the top experts from the international aviation industry;

ENGINE´S MAIN COMPONENTS DESIGN



ENGINE´S MAIN COMPONENTS DESIGN

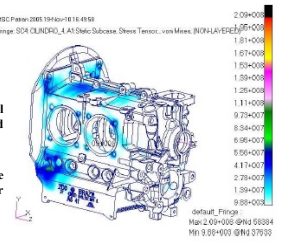
Sophisticated tools were employed to design the engine such as:

- Performance Simulations of intake and exhaust systems using GT-Power software;
- Valve Train Dynamic Analysis using GT-Power software;
- Bearing and Oil Film Analysis;
- FEA analysis of critical components;

ENGINE´S MAIN COMPONENTS DESIGN

Magnesium Crankcase Development

- VW Beetle engine layout was used as baseline on the initial analysis;
- FEA analysis using the typical aircraft gyroscopic loads and temperature variations;
- Blue areas are weak points of the regular VW engine cases for aircraft applications;

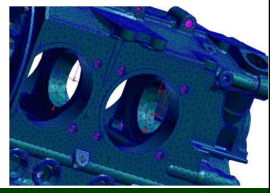


ENGINE´S MAIN COMPONENTS DESIGN

Magnesium Crankcase Development

Improvement of engine´s displacement

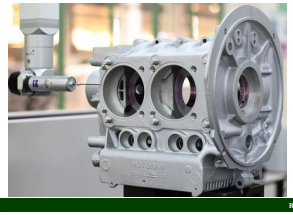
- **Regular VW Beetle engines: 1,6 liters;**
- **VW aircraft conversions: 2,3 liters max. with critical structural weaknesses;**
- **New MOTORAV engine case: 2,85 liters;**
- **More displacement ~ More HP;**



ENGINE´S MAIN COMPONENTS DESIGN

Magnesium Crankcase Development

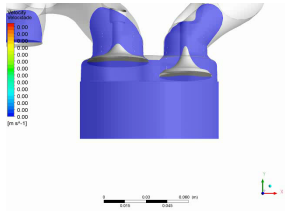
- **The new MOTORAV crankcases are produced by Rima Industrial in a 1600 ton DCM using the magnesium alloy AS41;**



ENGINE´S MAIN COMPONENTS DESIGN

Aluminum Cylinder Head Development

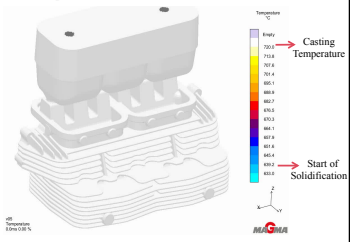
- **MOTORAV designed a new cylinder head to meet the 100 HP output aimed;**
- **The software GT-Power was used to design the intake and exhaust systems;**



ENGINE´S MAIN COMPONENTS DESIGN

Aluminum Cylinder Head Development

- **Intensive use of Magma casting simulation;**



ENGINE´S MAIN COMPONENTS DESIGN

Aluminum Cylinder Head Development

- **MOTORAV´s new cylinder head is produced by Rima Industrial using gravity casting process;**
- **Parts developed with the aluminum alloy AlSi7Cu3 modified with Sr and Ti;**

ENGINE´S MAIN COMPONENTS DESIGN

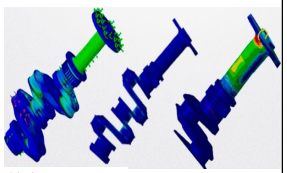
Aluminum Cylinder Head Development

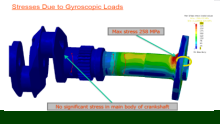
- **The cylinder head is a very critical part of the engine as it is where almost all engine´s heat is generated;**
- **The design included cooling fins in all hot zones;**
- **Aviation requirement: 2 spark plugs per combustion chamber for redundancy purposes;**

ENGINE´S MAIN COMPONENTS DESIGN

Steel Crankshaft Development

- **Stress / fatigue analysis with piston forces and propeller gyroscopic loads;**
- **Vibration modal analysis;**
- **Oil film / bearing load analysis;**





ENGINE´S MAIN COMPONENTS DESIGN

Steel Crankshaft Development

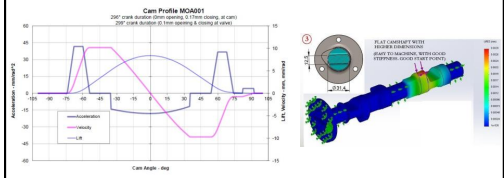
Forged crankshaft (4340 Steel);

Finished crankshaft

ENGINE´S MAIN COMPONENTS DESIGN

Steel Camshaft Development

- **Camshaft Design: Defines the engine performance (high HP / torque) at low rotations;**
- **GT-Power software: Valve Train Dynamic Analysis and design of Cam Lift curves of intake and exhaust systems;**



INNOVATION WITH INTENSIVE USE OF MAGNESIUM

Magnesium Camshaft Gear

- **Camshaft and Magnesium Camshaft Gear assembled;**
- **Camshaft gear is produced by Rima Industrial with AZ81 alloy using centrifugal casting technology;**

INNOVATION WITH INTENSIVE USE OF MAGNESIUM

Magnesium Cylinder Head Cover

- **Each engine has 4 Cylinder Head Covers die casted in AZ91 magnesium alloy by Rima Industrial in a 900 ton DCM;**

- **Finishing: Ceramic Tumbling;**
- **Surface Treatment: Silane based nanotechnology;**
- **Painting: Electrostatic powder coating;**

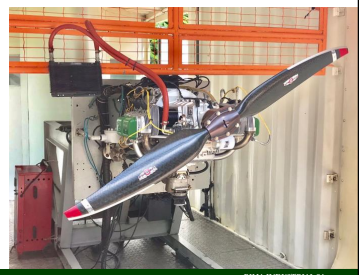
INNOVATION WITH INTENSIVE USE OF MAGNESIUM

Magnesium Intake Plenum and Oil Sump

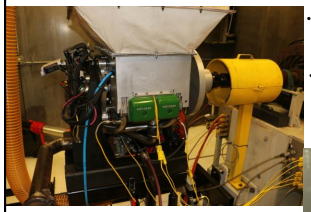
- **An intake plenum and a supplementary oil sump were designed to improve the engine performance;**
- **Both intake plenum and oil sump are produced with AZ91 magnesium alloy by Rima Industrial using gravity casting;**

STATUS OF THE ENGINE DEVELOPMENT

- More than 1000 test hours in bench tests at MOTORAV facility in Brazil;
- Use of Aviation Gasoline (AVGAS) or Automotive gasoline (MOGAS);



STATUS OF THE ENGINE DEVELOPMENT

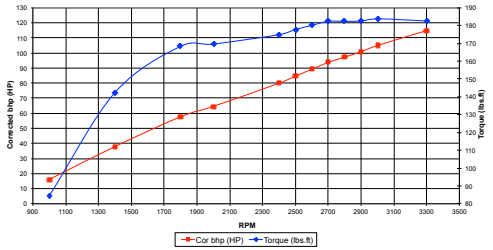


- FAA certified facility at Mobile area, Alabama – USA;
- Operation for 25 hours in a dynamometer test cell;

- Measured engine output: 104HP at 2900 rpm;

STATUS OF THE ENGINE DEVELOPMENT

- Corrected Power (HP) x Torque (lbs.ft) x Rotation (RPM)



STATUS OF THE ENGINE DEVELOPMENT

Lightweight Features

- Basic weight : 85,9 kgs (189 lbs) with 13,4 kgs (29,6 lbs) of magnesium alloys ;
- Weight to power ratio below 2,0 lbs/hp;
- The only modern aircraft piston engine with extensive magnesium content;

STATUS OF THE ENGINE DEVELOPMENT

- MOTORAV 100 HP Aircraft Engine as it will be on the market;

STATUS OF THE ENGINE DEVELOPMENT

Flight tests in Brazil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Thank You!
See more at WWW.MOTORAV.COM
Official Launching: July 2018´s EAA AirVenture Show at Oshkosh - WI;
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