RILSAN® HT BY ARKEMA

CASE STUDY

Producing crankcase ventilation lines for modern thermal engines with Rilsan® PA11

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INTRODUCTION

As efficient as an internal combustion engine can be, it's impossible to avoid some of the combustion gases fleeing through piston's segments to the lower part of the engine instead of being evacuated through the exhaust line. Without a proper evacuation of these gases – known as "blow-by" gases – pressure would continuously increase in the crankcase, which would ultimately lead to severe engine failures, especially because it would sooner or later prevent crankshaft dynamic seals to play their important role. All internal combustion engines are thus equipped with a more or less complex system of Positive Crankcase Ventilation (PCV) aiming at flowing these gases back to the combustion chamber (generally through the air intake manifold). PCV tubes are thus exposed to hot & chemically aggressive conditions.

Increasingly stringent environmental regulations have caused the automotive industry to move away from bulky, heavy and expensive rubber hoses towards thinner, lighter and lower cost plastic tubes to produce higher performance PCV lines with larger internal diameters. Rilsan® PA11 is one of the main solutions on the market. German OEMs have chosen Rilsan® HT flexible polyphthalamide (PPA) as the preferred solution because of particularly critical thermal and chemical requirements. In the United States, the requirement to increase gasoline engine performance has led to wider use of turbochargers and adoption of hybrid powertrains. These trends add system complexity which limit space and increase under-the-hood temperatures, driving the need for further use of Rilsan® HT PPA by OEMs and local tier manufacturers in order to meet these requirements.

SUMMARY

Objective

A PCV tube is a high performance system that needs to resist temperatures up to 225°C, and extremely aggressive chemicals, such as biofuels, acids and oils. As tube length and diameter increase, so does the need for lighter but still flexible & competitive solutions to replace traditional rubber (HNBR, AEM or FKM) or low performing plastics (PP, PA6, TPC-ET, etc.) solutions.

Partner

One of the biggest US OEMs and its main innovative tier for PCV application.

Industry

Automotive

Application

Positive Crankcase Ventilation (PCV) lines of most modern gasoline engines

Production process

Tube extrusion, smooth or corrugated

Material

Rilsan® polyamide 11 & Rilsan® HT polyphthalamide (PPA)

RILSAN® PA11

CHALLENGE

A chemically demanding application

Blow-by gases consist of a complex mix of engine oil, fuels, combustion residues, & acidic water. Their aggressiveness to polymers is increasing due to:

- The increasing aggressiveness of higher performance (low viscosity & friction) oils.
- Fuel & water content is increasing because of specific combustion conditions of direct injection engines.
- The increasing use of biofuels, which are polar and degrading to substances that promote more polymer hydrolysis.
- Acid composition is changing from purely strong (hydrochloric, nitric) to organic (acetic), which can be more aggressive to polymers.

➔ Long chain polyamides (LCPA) like Rilsan® PA11 or Rilsan® HT PPA have a strong advantage over other plastics. TPC-ET & PA6, for instance, are much more sensitive to hydrolysis and less resistant to acids than LCPA.

With a wide range of usage temperatures

Increasing CO_2 regulations have led to the development of more efficient, thus hotter, engines. More recently, the rise of hybrid vehicles with bigger batteries (48V) has drastically reduce under-the hood space compared to standard lead-acid batteries.

➔ Continuous use temperature (CUT) up to 130°C is now a standard, which is easily achievable with LCPA. For specific configurations leading to 160°C CUT or 180°C peak temperature, flexible long-chain PPAs like Rilsan® HT PPA are needed.

PCV tube needs to be flexible at ambient temperatures to ensure it can be easily mounted on the engine. With plastic tubes being less flexible than rubber hoses, it can be necessary to use corrugated tubes to aide in installation.

➔ For several decades, Rilsan® PA11 has been the solution of choice on fuel delivery module tube applications due to the material's excellent adaptation to the corrugation processes.

PCV needs to be active from vehicle start, thus also at very low temperature (down to -40°C). To avoid risk of blow-by gas freezing, some OEMs are forbidding the use of corrugated hoses, so that plastic solutions must have a sufficient flexibility on the whole temperature range.

➔ Long chain polyamides combine the excellent properties of polyamides, together with a great flexibility, around 500 MPa for Rilsan® PA11 and maximum 1000 MPa for Rilsan® HT PPA, and an outstanding resistance down to very low temperature (-60°C for Rilsan® PA11).

And a real environmental outcome

- Eco-friendly engines with a higher durability and a lower fuel consumption need a higher performance PCV.
- PCV systems aim at regenerating gases in order to reduce engine global emissions. Other systems such as exhaust gas recirculation (EGR), low-pressure EGR, selective catalytic reduction (SCR), etc., are increasingly used. These all utilize long chain polyamide tubes for chemical and/or thermal resistance reasons.
- Furthermore, many OEMs are looking for sustainable materials, which means:
  - A sustainable product range: Rilsan® polyamide 11 has a 70 year legacy of outstanding properties & innovation in automotive high performance applications,
  - A sustainable supply chain: With upcoming industrial investment, Rilsan® polyamide 11 will soon have the only truly dual sourcing supply chain among long chain polyamides.
  - A sustainable product: Up to 100% bio-based from castor oil (~ 50% for Rilsan® HT) and with an outstanding life cycle analysis profile, Rilsan® polyamide 11 has a real environmental value. Furthermore, specific programs also aim at certifying sustainable castor farming (Pragati) & developing partnerships for Rilsan® polyamide 11 regeneration (Virtucycle®).

SOLUTION

For standard operating temperatures, the product of choice is Rilsan® BESN Black P20 TL polyamide 11, with excellent references at several European OEMs for decades. With requirements becoming more and more severe, the use of Rilsan® BESN Black P210 TL is recommended when thermal requirements are higher (from -60°C to 130°C CUT). Finally, in case extreme thermal or chemical resistance is needed, Rilsan® HT CESV Black P010 TL can be used. The more flexible version, Rilsan® HT CESV Black P223 TL, can also be considered under specific conditions.

Recently, one of the biggest US OEM has approved Rilsan® HT CESV Black P010 TL PCV tubes. Those tubes have been in use for serial production on a first platform and should spread out on many more platforms in the near future. Desiree Maurer, Business Development Engineer at Arkema Inc. commented, "We are happy to be part of the collaboration with this leading OEM to make their vehicles more sustainable through the use of lighter, longer lasting, bio-based materials. Rilsan® HT PPA possesses all of the features this demanding application needs: an outstanding thermal & chemical resistance, high flexibility, and good process ability, which can be challenging for a high temperature product. It's a natural choice for engineers, both at Tier & OEM levels."

Arkema is a French public société anonyme incorporated in France (RCS Nanterre 319 632 790)
DIRCOM - Photos: Arkema, Getty – HPPNA - 2021-04

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