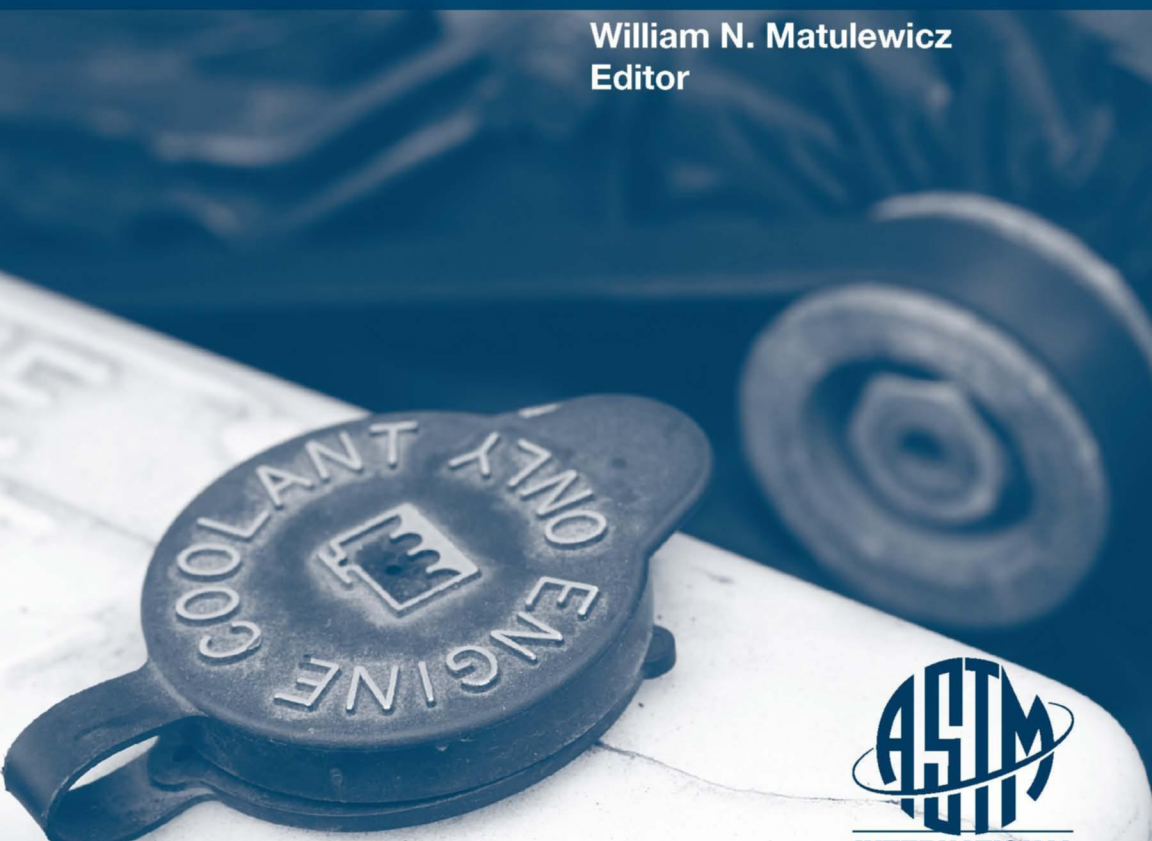
Engine Coolant Technologies

5th Volume

William N. Matulewicz
Editor



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Each paper published in this volume was evaluated by two peer reviewers and at least one editor. The authors addressed all of the reviewers' comments to the satisfaction of both the technical editor(s) and the ASTM International Committee on Publications.

The quality of the papers in this publication reflects not only the obvious efforts of the authors and the technical editor(s), but also the work of the peer reviewers. In keeping with long-standing publication practices, ASTM International maintains the anonymity of the peer reviewers. The ASTM International Committee on Publications acknowledges with appreciation their dedication and contribution of time and effort on behalf of ASTM International.

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Foreword

This ASTM international publication contains manuscripts from The Fifth International Symposium on Engine Coolant Technology sponsored by ASTM Committee D15 on Engine Coolants. Held in Toronto, Canada, May 2006, this symposium provided a forum for the presentation and exchange of information on advances in engine coolant system components, experimental testing, uses and users experience of both automotive and heavy-duty applications. These papers presented and contained in this publication, focused on areas of (1) international coolant development (2) field testing of coolant additives (3) engine coolant recycling (4) engine component and coolant additive compatibility (5) alternate coolant base technology (6) extended life oxidation and thermal stability (7) new testing methods of cavitation, erosion and localized corrosion. These presentations offered a view of the unique and ongoing research current in engine coolant technology. Much of the work presented is part of continued support offered to ASTM D15 to modify existing and to establish new standards for engine coolants.

Fifth International Symposium on Engine Coolant Technology

Opening Comments by William Matulewicz

This meeting marks my 20th anniversary in the ASTM D15 Engine Coolant Committee. I now qualify as one of the Old Guards at D15. Certainly not as high a level of Old Guard as Jess Starke and Frank Duffy, who are both at the Master Old Guard level, but certainly I have been in D15 long enough to be at the entry level of Old Guard.

When I attended my first D15 meeting I considered myself an expert in engine coolant technology. I was well versed in all of the ASTM D15 standards, which were all of those used in D3306, plus one or two additional standards. I knew how to formulate a high performance engine coolant. Basically, mix ethylene glycol together with phosphate/borate, silicone/silicate, nitrate/nitrite, tolyltriazole, a little dye (preferably uranine) and a little antifoam. Make sure to add enough caustic to yield the proper pH and RA, balance the DEG and water content and you had a very good engine coolant.

Don't forget the 12 months/12,000 mile rule. I still love the sound of that phrase, 12 months, 12,000 miles. If you turned the TV on and heard that phrase, you knew the air was getting crisp, the leaves were changing color and most importantly, it was time for football. Oh, and change your coolant. That's right, back then you actually changed your own coolant.

Those were good times, all you needed to know was phosphate/borate, silicone/silicate, nitrate/nitrite, tolyltriazole, dye (yellow) and antifoam. Sure, I had heard that there were some exotic formulas in Europe and a TEA/borate fluid in Asia, but we didn't pay much attention.

I walked into my first meeting and soon began my education in engine coolants. Apparently there were two sides to this engine coolant coin, coolants used in trucks and coolants used in cars. I also learned a new acronym, SCA. The truck guys actually added inhibitors to extend the service life of coolants, they did not honor the 12/12 rule.

The D15 committee was clearly divided with truck coolant on one side and car coolant on the other. The truck coolant side claimed that there was a problem with phosphate and silicate, something about inhibitor fallout, overheating, pump failures and green goo. What would you expect from a group that does not follow the 12/12 rule? D15 eventually constructed standards for these truck folk and established new definitions, such as, Heavy Duty and Light Duty. Both sides learned to reach across the line, embrace each other and work together to establish D15 standards. Thank goodness for recyclers!

OK, I could live with Heavy Duty standards, but I did not see the tempest of new standards to come in the following years. Little did D15 know that events in CT and TX were going to result in numerous new standards, definitions and debates.

The Lime, CT area was host to 2 historical events. The first was the disease traced back to a tick bite, hence the name Lymes disease. The second occurred at the same race track where Paul Neuman was known to race. A race team in Lime Rock was experimenting with reversing the coolant flow in an engine and using concentrated propylene glycol. Claims of better heat transfer, better gas mileage, better corrosion control and lower toxicity soon surfaced.

Over a number of years and much debate, D15 established standards and definitions for propylene glycol based coolants.

At about the same time down in TX, a man with a star was promoting engine coolants based on an additive that is used to make monofilament fishing line. It was claimed that this new longer, life fluid could last 30, 50 maybe even 100,000 miles. They wanted to totally trash the 12/12 rule!

This sebacic acid additive, long life concept grew in popularity, caught root, and landed in D15. Long Life standards and definitions were established and continue to be established today and include the Organic Acid Technology or OAT fluids.

By the mid-90s recycling engine coolants became a major issue in D15. Both OEM and the States were demanding performance and chemical standards for recycled coolants. Recycling technology at that time ran the gamut from passing used coolant through a machine with gauges and blinking lights coming out the other end virtually unchanged, to add packs that raised the pH, to reverse osmosis, to distilling and then adding inhibitors and buffers.

This recycle technology led to D15 standards for recycled coolants plus a host of new definitions such as; Recycled Coolant, Prediluted Coolant, Recycled Ethylene Glycol and Virgin Ethylene Glycol.

Along the development of OAT and long life fluids, not to be confused with extended service fluids, it was found that blending traditional coolant technology with OAT fluids could improve performance. This was the start of Hybrid fluids. I have heard the term HOAT to describe these hybrid organic acid technology fluids. I have heard the term NOAT to describe nitrite containing OAT fluids and MOAT to describe mixed OAT fluids. New research is now investigating developmental organic acid nitate technology, or DONT.

More standards, more research, more definitions, more challenges. Compatibility issues, oxidation stability issues, new technology issues. Being an expert in engine coolant technology in 2006 is a little more demanding than the 1986 expertise of phosphate/borate, silicone/silicate, nitrate/nitrite, tolyltriazole, a little dye (preferably uranine) and a little antifoam.

But being a new member of the Old Guard at D15 I am entitled to long for days past, meetings with no cell phones or lap tops and breaks with long lines at the pay phone. Days when blackberry was a fruit, blue tooth meant a trip to the dentist and yahoo meant you were really excited.

20 years ago was a simpler time when 12 months and 12,000 miles ruled.

Contents

Overview

In May of 2006, the ASTM D15 Committee on Engine Coolants sponsored the Fifth International Symposium on Engine Coolant Technology in Toronto, Canada. The advances in coolant system components and construction continue to impact the modern automotive, heavy-duty, locomotive and free standing engine design and performance. The expanding use of lighter metals, advances in non-metallics, changes in fluid control technologies and coolant filtration in todays engines, plus advancing discoveries in EGR and fuel cell technologies in engines of the future are a few of the challenges facing the experts in engine coolant formulating. Challenges of today include extended service life, liner pitting, the impact of EGR, advances in turbo charging and component compatibility. Research areas must consider state and local regulatory requirements for increasing the use of recycled fluids and efforts for global standardization of test methods.

The symposium presented an open forum for the presentation of new research in modern engine coolant formulating addressing the complex issues mentioned above. The symposium was well attended by international technical representatives from OEM and engine coolant producers. The presentations were followed by open comments and questions from the attendees resulting in a robust, professional exchange of ideas.

The contents of this STP are the fourteen papers presented at the Fifth International Symposium on Engine Coolant Technology after the completion of a thorough peer review, which included author(s)/editor(s) exchange of comments and suggested revisions, according to the guidelines of the ASTM Editorial Staff. These papers include current overviews of heavy duty coolant technology and coolant development in Asia, new testing methods, both in field and at the bench, designed to help determine localized corrosion by electrochemistry, erosion corrosion, degradation of coolant components at elevated temperatures and under accelerated oxidation, and depletion of corrosion inhibitor additives. Compatibility issues are also presented addressing both multi-fluids mixing and affects of fluid composition on engine components.

I want to thank the reviewers that volunteered their valuable time to complete the critique of the papers presented. I also wish to thank the ASTM Editorial staff for providing the guidance and expertise that enabled the successful completion of the Fifth International Symposium on Engine Coolant Technology and the construction of this STP.

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