Design and Development of Automotive HVAC Systems

PUBLIC COURSE INFORMATION: October 11-12, 2010 in Southfield, MI. ($1,195/Student, Group Discounts are Available - 2-5 Students: $995/Student, 6 or More Students: $795/Student), Also available on-site at your location, call us for pricing information. REGISTER HERE

GOAL OF COURSE: Provide the basic fundamentals for a systematic approach in the design and development of an automotive, agricultural, military, off highway equipment HVAC systems that meet all customer expectations and comfort.

OBJECTIVE: The objective of the intensive two day HVAC seminar is to study the different components of the Automotive HVAC system and to demonstrate how they may be combined to produce an effective, pleasing to the customer product. Emphasis is placed on safety, quality, timing and cost. The contribution of the HVAC system on emissions and fuel economy is also presented. The importance of communication and interaction with different engineering groups and disciplines are stressed to enable the most efficient packaging of the HVAC system within the real estate constraints of the vehicle.

AUDIENCE: Although the seminar is directed to HVAC designers, technicians and engineers, its purpose is to also inform and familiarize HVAC basic concepts to those areas which are involved with HVAC. These would include program management, design studio, packaging, materials, manufacturing, CFD, engine cooling, aerodynamics, thermodynamics, engine control and scientific laboratory groups.

PHILOSOPHY OF DESIGN: The customer's comfort from both physiological and safety view points is the basis of design. The power requirements of the HVAC system and its impact on emissions and fuel economy, warranty, cost and packaging are also a part of the design basis.

DESIGN PROCEDURE: The presentation is divided into four parts, i.e., Hardware, Fundamentals, Design and Development. The students are first introduced to the various components, their function and their location in the HVAC system. Fundamental heat transfer equations and HVAC thermodynamic principles are then discussed. A detailed model design roadmap is then specified and the evaporator, compressor and condenser are sized. The front end (condenser) and cabin (evaporator) air flow needs are established and the required air moving and distribution components are selected. A comparison of the theoretical and actual compressor horsepower is made.

The heater is discussed as a distinct part of the HVAC system including its performance dependence on coolant flow (engine pump) and coolant heat quantity (spark strategy). Properties of the coolant and corrosion are presented. The routing of the heater and AC lines and connections are a part of this design model.

The advantages and disadvantages of different flow devices, i.e., fixed orifice tube, variable orifice valve, thermal expansion valve and constant pressure valve are discussed. The methodology of sizing the flow devices based on the refrigerant requirements is presented. The importance of properly sized and routed AC plumbing and connections is included as part of the flow device design.

The HVAC control system function and its major components, both ATC and manual, are investigated. The importance of the control system relative to customer satisfaction and protection of the AC and heater components is stressed.

DEVELOPMENT PROCEDURE: the students are introduced to the different development tests required to finalize the HVAC design. The importance of first doing an analytical analysis of the expected results and then confirming the results in an environmental chamber, wind tunnel or in the field is emphasized. The comparison of actual performance to ideal performance is stressed.

The test procedures discussed include:

a. in vehicle air, refrigerant and coolant flow non-uniformity and correction of the supplier's performance curves.

b. determination of the front end and cabin air flow phenomena.

c. sizing of the body exhausters.

d. methodology for determining refrigerant quality and isentropic efficiency.

e. condensate balance, water carry over and odor prevention.

f. standard soak, cool down, warm up and defrost tests.

g. sizing the orifice tube and thermal expansion device.

h. refrigerant and compressor oil charge and OCR (oil circulation rate) determination.

i. determining optimum refrigerant condenser subcooling and evaporator superheat.

j. juries and field testing procedures.

ASSOCIATED AREAS: The use of alternative refrigerants, including carbon dioxide, the anticipated Revised Federal Test Procedure and its affect on emissions and eventually on fuel economy, component and system warranty and durability, the setting of functional objectives, OEM and Supplier relations and a general approach on how to most effectively accomplish the goals of designing and developing a world class HVAC system while still meeting cost and timing constraints are all an integral part of the design and development presentation.

INSTRUCTOR'S EVALUATION: An evaluation of the seminar is provided to the seminar requester as part of a Summary Report submitted at the conclusion of the seminar.

INSTRUCTOR: Alexander Kargilis, P.E. has over 40 years experience in the design and development of automotive, truck, military and off highway vehicle HVAC and Engine Cooling components and systems.

He has written HVAC and engine cooling design and development texts, test procedures and standards used throughout the USA and world.

He works with automotive OEM and suppliers in the optimum sizing and application of all the units that comprise these systems both as individual components and as viable operating systems in an automotive city, highway, off-highway and military vehicle environment.

He is an engine cooling and HVAC consultant throughout the USA, Canada and Europe. His course alumni include all the major automotive and off highway vehicle manufacturers and suppliers, i.e., General Motors, Ford, Daimler-Chrysler, John Deere, Toyota, Volvo, J I Case, Visteon, Delphi, Denso, Sanden, Calsonic, Siemens, Behr, Modine, Caterpillar, TRW, Tesma, Halas, Goodyear, Peterbilt, Honda, Fiat,Cummins, Dana, Nissan, Bosch, US Army Command, Kenworth, Long, Freightliner, Harley-Davidson and many others.

He received his engineering degree from Wayne State University, has several patents on heat transfer devices used in the automotive industry, is on the adjunct faculty of the Lawrence Technological University in Southfield, Michigan and is a registered professional engineer.

His expertise in the design, development and manufacture of automotive engine cooling and HVAC components and systems has been proven and fine-tuned over many years in the laboratory, manufacturing plant, on the test track and millions of miles in the field.

HVAC Syllabus, Day one, AM

Initial technical survey; Introduction; HVAC history; Hardware; Design procedure outline; Design fundamentals; Basic heat transfer equations and thermodynamic principles; Begin AC model roadmap; Specify conditions; Body leakage curve; Psychrometric concepts; Air enthalpy; Dry and wet bulb temperatures; Specific humidity; Determine evaporator duty; Select evaporator; Determine refrigerant flow; Determine AC compressor requirements at constant entropy; Evaporator and compressor performance curves; Ideal reverse Carnot cycle (PH diagram); COP (coefficient of performance); Problem set 1.

HVAC Syllabus Day one, PM

Front end system resistance to air flow curve; Condenser fan curve operating point; Determine condenser duty, superheat and subcooling; Condenser performance curve; Air flow requirements; Fan size; Complete first road map model; Investigate additional conditions; Sizing of flow devices; Desiccants; Plumbing suction and discharge lines; Air distribution system; Blower wheel and motor; Positive and negative pressure coefficients; Problem set 2.

HVAC Syllabus Day two, AM

AC outlets: Heater outlets; Defrost and demist outlets; CFD airflow analysis; Spreading factor; Target velocity; Temperature and plume area at the target; Defroster design guideline; Exhausters; Negative pressure coefficients; NTU; Heater design; Coolant pump; Heater performance curves air and coolant side; Heater overall, outside and inside heat transfer coefficients; LMTD, Reynolds number; Effectiveness; Performance variables; Engine spark strategy; Corrosion and fouling; Controls, manual and automatic; Blend air linearity curve; Durability concepts; Warranty; Refrigerants; EPA driving cycle; OEM-Supplier responsibilities; Development- Laboratory equipment; Development plan; Functional objectives; Determine body leakage and blower curves; Problem set 3.

HVAC Syllabus Day two PM

Development- Condenser air flow; Fan and shroud characteristics; Fan design; Fan selection; Determination of mass air flow through condenser; Non-uniformity correction to supplier performance curves(evaporator, condenser, fan, blower, compressor, heater; Front end system resistance; Viscous drives; Seals; Charge determination; Superheat determination; Duct and outlet balance; Condensate freeze up, water carry over and odor; Hot soak and cooldown; Highway to extended idle; Cold soak and warm up; Field trips; Subjective juries; Durability analysis; Refrigerant Quality; Review.