HII: From Pioneer to Industry Leader in Automotive Emissions Measurement

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Abstract

Dr. Masao Horiba and Dr. Masahiro Oura personally introduced the HORIBA NDIR to the U.S. automotive market in the mid-1960s, selling their first instrument to the Ford Motor Company. A joint venture, Olson-HORIBA Incorporated, was formed in 1970 to build emissions systems with HORIBA analyzers. HORIBA purchased the Olson portion of the company in 1972, reincorporating the company in California as HORIBA Instruments Incorporated (HII). Over the ensuing 30 years creative employees at HII initiated many new HORIBA products, including the venturi CVS, automation computer systems, electric dynamometers, turn-key systems, project management, 48 inch dynamometers, and the Bag Mini-Diluter. Details are reported.

1 Introduction

Concurrent with the discovery in California of the link between automotive emissions and smog HORIBA developed its first NDIR analyzer for medical (breath) applications. The HORIBA NDIR aroused the interest of a Japanese government researcher who asked HORIBA to build an experimental automotive emissions system. The emissions system supplied by HORIBA was successful and established the HORIBA name with Japanese automotive manufacturers. However, a slow economy in Japan prompted Dr. Horiba and Dr. Oura to take a “portable” NDIR analyzer to the U.S. for demonstration to the American automotive industry. They traveled by bus and stayed in YMCAs as they visited U.S. automotive manufacturers. Ultimately Ford became the first U.S. customer when it purchased a demonstration analyzer. The U.S. automotive emissions market potential led HORIBA to establish a joint venture Olson-HORIBA, Incorporated (OHI), in 1970, with an emissions systems manufacturer, Olson, Incorporated, an established, leading systems vendor in the evolving U.S. emissions market. Olson-HORIBA operations were located in Irvine, California because many employees were recruited from high tech industries in the area.

The Northrop aerospace corporation purchased Olson’s interest in OHI in 1972 to gain control of HORIBA product sales in the U.S. Clever negotiations by Dr. Horiba concluded with HORIBA acquiring Northrop’s stock in OHI. The fledging company was re-incorporated in California as HORIBA Instruments Incorporated (HII). HII continued the original focus, selling HORIBA analyzers and designing and constructing custom emissions analysis systems for automotive manufacturers and major component vendors.

The U.S. EPA issued in 1970 national automotive emissions standards incorporating a new mass sampling procedure using a Constant Volume Sampler (CVS). Subsequently the Philco-Ford Corporation patented an improved CVS design that utilized a critical flow venturi for the mass flow measurement. HII purchased the patent for the Critical Flow Venturi type CVS (CFV-CVS) and moved into the leadership of emissions systems vendors.

Over the following three decades the creative staff at HII produced a series of new and innovative products for automotive emissions measurement. The electric inertia dynamometer, the first 48-inch emissions dynamometer, subsonic venturi CVS, the CFV based bag mini-diluter, and numerous test cell automation computer systems are just a few examples.

2 Automotive Emissions Measurement Leads Growth and Development of HII in the U.S.

Automotive exhaust emissions of CO and HC were identified as the major source of air pollution by researchers in California during the 1950s. This discovery led to California's first automotive emissions regulations for vehicle exhaust. The California Air Resources Board implemented a new vehicle emissions test procedure that analyzed raw, undiluted concentrations of tailpipe exhaust during a Seven Mode/Seven Cycle driving procedure that simulated over-the-road driving on a chassis dynamometer. Non Dispersive Infrared (NDIR) analyzers measured concentrations of CO, CO_2 and HC for pass/fail limits based upon average concentration computed from selected segments of the test procedure. Results were generally computed by manual measurement of the specified portions of the test results, which were recorded on strip chart recorders. Many of the first HORIBA NDIR analyzers sold in the U.S. by Olson-HORIBA were applied to this California test procedure.

During the 1960s, other cities in the U.S. were experiencing air pollution problems similar to California. These events prompted the U.S. Congress to create the Environmental Protection Agency (EPA) and pass the Clean Air Act of 1970 that established goals for automotive emissions reductions. The EPA was given broad responsibilities to regulate motor vehicle pollution via federal regulations. EPA created a new transient driving procedure, the Federal Test Procedure (FTP), based upon typical commuter driving in the Los Angeles air basin. Emissions from the FTP are determined by a mass based analysis technique employing the Constant Volume Sampler, a sampling technique that dilutes the exhaust with filtered air at a constant mass flow rate. A small, proportional sample is collected in an inert bag and analyzed as an integrated sample. Like the California test, CO and CO_2 are measured by NDIR but the EPA elected to measure HC as total hydrocarbon using a Flame Ionization Detector (FID). A third pollutant, Oxides of Nitrogen (NOx), was added to the list of pollutants for analysis by chemiluminescent analyzer.

3 HII Acquires the Venturi CVS

About the time the U.S. operations were re-incorporated as HII, the Philco-Ford Corporation patented a new CVS based upon the critical flow venturi (CFV), a more accurate mass flow device than the positive displacement pumps initially used in CVSs. In a bold move HII purchased the patent rights to the CFV-CVS from Philco-Ford, a move that would soon establish HORIBA as a key vendor for automotive emissions analytical systems, a large shift from merely being a supplier of exhaust gas analyzers. This opportunity occurred in 1975 when HII delivered a CFV-CVS based emissions system to the EPA's vehicle emissions laboratory in Ann Arbor, MI. This delivery to the EPA meant the HORIBA CFV-CVS was well on its way to becoming the global-standard CVS, which history has shown.

HII operations grew slowly but surely over the first few years of activity in the U.S. There were many challenges to overcome but under HII supervision the HORIBA products gained a reputation in the U.S. for reliability and accuracy. Analyzers from HORIBA Ltd. were shipped by ocean transit and required thorough inspection before delivery. Frequently U.S. customers demanded customization so systems manufacturing was essential. HII headquarters and manufacturing located in a new building in Irvine, CA, and a sales office was located in the Detroit area close to the U.S. automotive customers.

4 Expansion into Turnkey Systems

In the mid 70's HII sales activity expanded into complete turnkey systems, which included analyzer benches, CVSs, and computer automation systems. During the development of a turnkey system for Ford, HII exercised the opportunity to purchase the computer automation business for automotive applications from Interautomation, a Canadian company. The new automation group located in Ann Arbor, MI, which had become the focal center of U.S. automotive emissions. Within a year the HII sales office and the automation group were integrated into a single facility in Ann Arbor in what was to become the HORIBA Automation Division of HII, a group know today as HAD. In addition to supplying CPUs for turnkey sales in the U.S. the HAD programmers became the global software systems partner for HORIBA's global automotive sales in Europe and Asia too.

HII quickly became a full service vendor in the automotive emissions market with engineering in Irvine building analyzers systems (known as benches) and HAD automation in Ann Arbor supplying software and computers for a series of U.S. designed turnkey emissions systems. In 1977 HII received its first major order from the Ford Motor Company for eight test cells with benches, CVSs, and computer automation systems. During this period many other automotive manufacturers in the U.S. and around the world recognized HAD's expertise and purchased a HAD Vehicle Emissions Test System (VETS) with HORIBA benches and CVSs supplied by the local HORIBA group company. Today many manufacturers have in-house software services, yet they still relay upon HII VETS computer systems for their critical emissions test systems.

5 HII Develops the Electric Inertia Chassis Dynamometer and the 48 inch A/C Dynamometer

The next step forward for HII was the design and introduction of the twin-roll electric inertia chassis dynamometer, which it introduced in 1980. The new dyno was the first dynamometer to offer precise simulation of road load inertia without flywheels. The HORIBA electric dynamometer offered vast improvements in repeatability and accuracy in addition to simulation of actual road-load conditions, an advantage over the fixed load curve of the traditional, hydrokinetic dynamometer. Customer engineers quickly recognized these advantages and soon HII dynamometers were distributed worldwide.

As successive steps in emissions regulations pushed tailpipe concentrations lower, EPA recognized a need to improve and extend the performance of the emissions chassis dynamometer, especially for a new high speed, high acceleration US-06 Supplemental Test Procedure. The traditional 8.65-inch twin-roll dynamometer let the tires slip during hard acceleration and could cause tire failure at high speed so EPA bid specifications called for a new 48-inch, single roll dynamometer. HII's dynamometer engineering group won the EPA international bid competition with a new 48-inch single roll electric dynamometer capable of speeds in excess of 100 MPH and inertia simulation to within one pound of test vehicle weight. HII received a contract to supply up to 20 of its new 48-inch dynamometer to EPA laboratories. Fig.1 shows the 48-inch Electric Chassis Dynamometer. Today the HORIBA 48-inch motor-in-the-middle dynamometer design is required for all EPA certification test procedures.

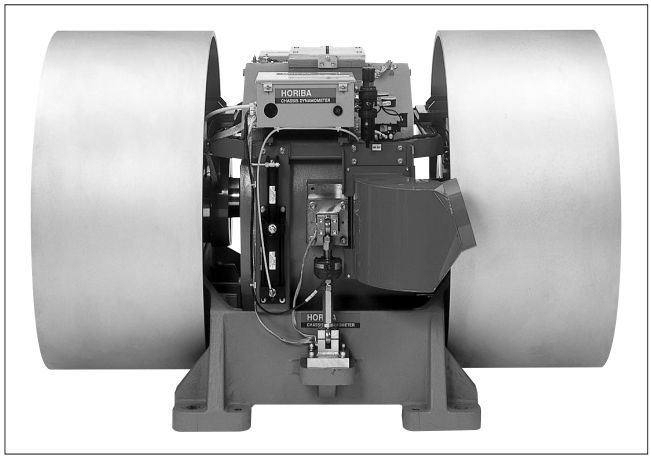

Fig.1 48-inch Electric Chassis Dynamometer

6 A Step Forward Into Facility and Project Management

In 1986 HII received a $10 million contract from the new Saturn Division of GM to build a turnkey emissions facility at its engineering headquarters. This Saturn contract led to the expansion of HII services into Project Management, including facility design, construction contracting, specification and installation of equipment, and start-up of the completed facility.

7 HII Product Development

HII technical leadership has been especially strong in emissions sampling systems. After the purchase of the CFV-CVS patent, HII engineers contributed several new innovations to the CVS product line. A subsonic venturi CVS was patented in 1978 in response to manufacturers' interest in selectable flow-rates to more closely match CVS flow with a wide variety of engine sizes and types. Today the SAO-CVS is frequently used in Heavy Duty Diesel CVS tunnel systems where its unique flow control can optimize flow rates to closely match engine exhaust characteristics.

Another HII patented product is the Low Loss Remote Mix Tee. This clever innovation uses the pressure characteristics of a gas flowing in an elbow to control the overall system pressure effect at the tailpipe to within a specified 1-inch of water during the FTP. This passive design eliminates expensive, active control systems previously required to meet requirements for large engines.

In 1993-1994 the EPA issued a new vehicle inspection regulation called IM-240 for "enhanced," or high, smog areas around the country. HII responded with a low cost, high quality combination CVS and modal analyzer system that quickly became the industry standard. HORIBA produced a set of special purpose, laboratory grade IM-240 analyzers for the HII system. To HORIBA's credit, most of these systems have been in daily, high-volume testing service for 10 years without significant problems.

During the 1990s AIGER, a consortium of the U.S. government and automotive industry, created specifications for a new emissions sampling system called the Bag Mini-Diluter (BMD). While the AIGER members developed a mass flow controller based BMD, HII independently developed and patented a BMD using the critical flow venturi. Data from the HORIBA BMD was instrumental in industry gaining EPA approval to use the BMD for certification of future SULEV super-ultra-low emission vehicles. The BMD is the first alternate sampling system to be approved by the EPA to replace the CVS since the initial Federal Test Procedure was defined in 1970. In 2003 EPA awarded HII a contract to install BMDs and MEXA equipment in three test cells at the EPA laboratory in Ann Arbor. This new HORIBA equipment will enhance EPA's ability to accurately measure emissions from Super Ultra Low Emission vehicles. Fig.2 shows the HII headquarters in Irvine, California.

Fig.2 HII Headquarters in Irvine, California

8 Globalization of HORIBA Products

As automotive manufacturers expanded operations to multi-national facilities, HORIBA recognized a growing need for global products to offer the customer the same product anywhere in the world. HII, HORIBA Europe GmbH, and HORIBA embarked upon joint development of global products with specific design responsibilities assigned to the HORIBA organization with the most advanced expertise. HII's contribution to HORIBA global development has primarily been HAD's software expertise. HII first designed and coded the VETS-NT, which has become a global product supported with local customization by each group company software services.

The MEXA-7000 became the first truly global HORIBA emissions analyzer system. The magnitude of the project required frequent communications between engineers in Europe, the U.S., and Japan. To facilitate communications and teamwork, HII engineers were exchanged with HORIBA engineers. With this high level of international cooperation the MEXA-7000 product was successfully launched in a short period of one and a half years. HII programmers coded their assigned parts of the MCU software, exchanging code each night with team members in Japan.

In 1995 HII purchased more than 14 acres of land in Ann Arbor and constructed a 35,000 square foot building for HAD sales, service, and software operations. Just two years later HII expanded the building and added a state-of-the-art chassis emissions test cell in response to frequent customer requests. The test cell is frequently used to demonstrate the latest HORIBA MEXA emissions systems. In addition, HII is able to provide automotive customers with off-site testing services for pre-delivery prove-out of turnkey systems. This has been especially valuable in reducing on-site installation and start-up time, extremely important savings to the customer. Fig.3 shows the new HAD building in Ann Arbor, and Fig.4 is the HAD test cell showing vehicle on dyno with MEXA-7000 instruments in the background. Table 1 shows the history of HORIBA and EMD in the United States.

Fig.3 New HAD Building in Ann Arbor

Fig.4 HAD Test Cell Showing Vehicle on Dyno with MEXA-7000 Instruments in the Background

Table 1 A History of HORIBA and EMD in the United States

1970	Olson-HORIBA, Inc. a joint-venture corporation is established in the U.S.
1972	Northrop purchases Olson shares in Olson-HORIBA. HORIBA buys the Northrop shares and re-incorporates OHI as HORIBA Instruments Incorporated (HII).
1975	HII acquires the Critical Flow Venturi CVS patent from Philco-Ford.
1975	HII delivers first HORIBA emissions system to EPA laboratory in Ann Arbor.
1977	HII purchases Interautomation computer automation group and establishes HAD in Ann Arbor, MI.
1980	The electric inertia chassis dynamometer is developed by HII for vehicle emissions testing.
1985	The HORIBA 200 Series analyzers are introduced for HII customers in the U.S.
1986	Saturn Division of GM awards HII a contract to build emissions engineering facility at the company's engineering headquarters in Michigan.
1991	The 48-inch single roll A/C dynamometer is developed under contract to the EPA.
1994	HORIBA provides over 450 IM-240 systems for new EPA vehicle inspection regulations.
1995	The Venturi BMD is developed by HII.
1997	HAD builds a chassis emissions test cell at its Ann Arbor building.
2001	The BMD wins EPA approval as an alternate to the CVS.
2003	EPA awards HII Tier II contract for three BMD Test cells.

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