THE DISCOVERY OF A NEW DIMENSION IN HETEROGENEOUS CATALYSIS: THE BASIC PRINCIPLE WHICH REVOLUTIONIZED THE SCIENCE OF POLYOLEFIN MATERIALS.

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The amazing potential of polyolefin (PO) materials began to be unlocked with the discoveries, in 1953 and 1954, of the catalysts for polyethylene (PE) and polypropylene (PP) by Prof Ziegler and Prof Natta.

Those early, but fundamental, steps were the first of what was destined to be a gradual but steady path to towards extraordinary scientific and industrial success, although not without challenges and set backs along the way. Without doubt, however, those early breakthroughs in PP catalysis -the product of much effort, trial and error- laid the foundations for the subsequent development of PE and the family of PO materials at large.

The focus on the development of PP was soon to follow, and the early stages in that effort, aimed at an understanding and then identifying a solution of the critical PP technology's problems, elevated the Ferrara technology school - with its cutting edge R&D on PP - to worldwide fame.

Indeed, the history of PP and its scientific and industrial achievements are inevitably intertwined with Ferrara and, as such, the history of PP is a true and original "Ferrarese story".

And it's a story which generated three fundamental R&D discoveries; three projects and ultimate successes which find in Ferrara their spark and main theater, and which ultimately constituted the paramount commercial successes of the Ferrara technology school:

(1) the development of a generation of revolutionary catalysts, PO processes and products, all based on the discovery of the "new dimension" in heterogeneous catalysis;

(2) the discovery of a novel, high-yield, high productivity liquid monomer EPDM process; and

(3) the development of the Ziegler-Natta "Reactor Granule Technology" (RGT), which in turn laid the foundation for the development, in Ferrara, of the largest Ziegler-Natta catalyst commercial production unit in the word.

It was those fundamental Ziegler-Natta discoveries in the early 1950ies which spurred the drive and enthusiasm of a new generation of scientists who had detected the potential of the field and which ultimately resulted in the discovery of a revolutionary catalyst. This was the catalyst which made it possible for materials like PE and PP to be generated with the use an innovative, accessible technology, capable of operating in mild conditions while producing quality and low cost materials.

And those scientist's enthusiasm and ambition was shared by the top management of Montecatini, which led to launch, in November 1955, of a large–scale pilot plant for the polymerization of ethylene in Ferrara. This was followed, in January 1957, by the commencement of operations of the first multipurpose batch polymerization plant for the production of high density injection molding PE and PP, and then in November 1957 the launch of the first large scale PP commercial plant, both of which also in Ferrara.

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However, those early scientific successes and the optimistic expectations they had fuelled did not meet an equally smooth and encouraging commercial application. In fact, the early production phases were full of challenges: the plant was besieged by operational difficulties and glitches, its performance unreliable, and its output disappointing. The catalyst consumption and the production costs were prohibitively high; the polymer's properties at best simple and poor; while the plant's processes were rigid and not susceptible to easy fixes, and also environmentally inadequate. Yet, the cause of such failure remained a mystery for years to come, and these difficulties were not exclusive to the Ferrara plant. The industry as whole, on a global scale, was struggling to develop an effective commercial application of those earlier scientific discoveries, despite the efforts being spent by an increasingly large number of petrochemical companies across the world.

Ultimately, the Ferrara R&D team came to the conclusion that the problem lied in a fundamental and original misconception in the basic structure and process of the catalyst. The team began to work on the concept and structure of an "Ideal Model Catalystic", a catalyst whose structure and requirements had to be first fully understood on a theoretical and scientific level, and then acted upon in order to identify and fine tune its ideal properties, such as activity, selectivity, granule morphology and, ultimately and down the line, the final properties of the wide range of materials whose production such catalyst would make possible.

Indeed, that ambitious program was named "Identification of the IDEAL Catalyst", and its founders set for themselves the dateline of the mid 1970ies to achieve this goal. The efforts quickly focused on the chemical and physical-mechanical phenomena linked to polymerisation, which led to two major breakthroughs in the understanding of catalyst activity and architecture:

(1) The discovery of the "Delta" $MgCl_2$ support made in Ferrara in 1968; and

(2) The discovery of the real "New Dimension" in heterogeneous catalysis.

These discoveries finally allowed these scientists to achieve full control and visibility of the catalyst-polymer granule genesis and growth, which in turn were the premises for the development of the "RGT". It was a series of developments which ended up transforming and re-inventing the entire field of PO materials and drove the industry's development in the following 40 years -- resulting in the identification and successful commercial development of new processes, materials and their applications.

It truly was a victory snatched from the jaws of defeat, whereby in a range of a few years the outlook of the potential of the entire PO industry was turned upside down, leading to a string of discoveries, new processes and technologies commencing from the early 1980ies which remain relevant and widespread in use to this day. It was a breakthrough in the history of polymeric materials which has had no equal.

It was the "Ideal Catalyst" project that led to identification and development of, indeed, the ideal technological solution to the problem and thus to the birth of the RGT technology which, certainly, would not have been possible otherwise.

But it's a story whose final chapter has not been written yet and it reserves many engrossing chapters for the future…

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Prof. Galli at FasTech stand during INCOREP.

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