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A Glimpse of Pyrometallurgy at Wits University

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Abstract – Wits Metallurgy celebrated its centenary in 2004. The department has been at the forefront of education and research and has contributed greatly to the metals and minerals industry, both in South Africa and abroad, in terms of human resources and knowledge generation. A significant number of industry and academic leaders worldwide are Wits Metallurgy graduates. Since its early beginnings, pyrometallurgy has always been part of the curricula and research offered by the department. Pyrometallurgical activities started to expand tremendously from the middle of the 1960s, especially by the formation - together with Mintek - of the Pyrometallurgy Research Group, which continues its internationally recognised research activities today. The research efforts have been concentrated on problems associated particularly with ferroalloy, steel, stainless steel production, and PGM/Cu-Ni sulphide smelting. In recent years, research has been further expanded to physical modelling of pyrometallurgical reactors. Almost all of the specific research projects were handled from a fundamental point of view, and hence a large number of MSc(Eng) and PhD degrees were achieved by candidates under the supervision of the Pyrometallurgy Research Leaders. Moreover, a significant portion of the research results were published in internationally recognized journals and conference proceedings. Among these, Infacon and the Molten Slags, Fluxes and Salts Conference series are worth mentioning. The studies from a fundamental point of view include thermodynamics, phase equilibria, transport phenomena, kinetics, and process dynamic aspects of high temperature processes and systems, both in the solid and liquid states.

PAST HISTORY

Wits Metallurgy celebrated its centenary in 2004.[1] The Metallurgy Department has gone from strength to strength since it started with the appointment of Prof. G.H. Stanley as the first chair/head of Metallurgy at the Transvaal Technical Institute in Johannesburg. In 1922, the University of the Witwatersrand was born from the Institute, which incorporated mining engineering, geology, and metallurgy. The Metallurgy Department at Wits has been at the forefront of education and research, and has contributed greatly to the metals and minerals industry, both in South Africa and abroad, in terms of human resources and knowledge generation. A significant number of industry leaders worldwide are Wits Metallurgy graduates.

The department has always been sensitive to the needs of industry and society in general, and has developed and adjusted its curriculum and research

accordingly. Early years until 1934 were mostly devoted to teaching and producing graduates (although in small numbers) for the industry. In April 1934, with the formation of the Minerals Research Laboratory, a joint venture between the University and the State (Mining Department), research was given a strong boost. Prof. Stanley became its first director until his retirement at the end of 1939. The research focused on recovery of metals and minerals from ores, such as corundum, vermiculite, tin, stainless steel, chromites, and diamonds, and on the utilization of titaniferous iron ores.

From 1940 until his retirement at the end of 1958, Prof. L. Taverner was the chair/head of Metallurgy and Director of the Minerals Research Laboratory and Government Metallurgical Laboratory from April 1944. Initially, the research effort concentrated on the requirements of the war. Work on phosphates, corundum, and vermiculite continued as well. Another noteworthy wartime activity was in the fields of ceramics and refractories. After the war, from 1946 to 1959, research focused on uranium, and to a lesser degree on electrolytic manganese. Moreover, physical metallurgy was also gaining momentum, especially corrosion studies.

Between 1959 and 1962, Prof. C.E. Mavrocordatos led the Metallurgy Department. Prof. D.D. Howat took over the headship from the beginning of 1963, and remained as chair/head until his retirement at the end of 1975. Since then, the headship of the department has become more of a rotating position than a permanent one, which also coincides with the establishment of the prestigious Chamber of Mines Chair of Extractive Metallurgical Engineering. The incumbents of this chair have always been heads of Metallurgy, except for the rather short term of Prof. G.G. Garrett during 1984 and 1985. Prof. R.P. King was the first COM chair/head of Metallurgy until 1990, and Prof. R.H. Eric is the second and current COM chair/head of Metallurgy.

PYROMETALLURGY

Pyrometallurgy research at the Metallurgy Department of the University of the Witwatersrand has been one of the major research thrusts since the mid 1960s. When the industrial boom in the ferro-alloy and steel industries started in the late 1960s, the department, together with Mintek, established the Pyrometallurgy Research group, which continues its internationally recognised research activities today. The research efforts have been concentrated on problems associated particularly with ferro-alloy, steel, stainless steel production, and PGM /Cu-Ni sulphide smelting. In recent years, the research has been further expanded to physical modelling of pyrometallurgical refining reactors. Almost all of the specific research projects were handled from a fundamental point of view, and hence a large number of MSc(Eng) and PhD degrees were achieved by candidates under the supervision of the Pyrometallurgy Research Group Leader. Moreover, a significant portion of the research results were published in internationally recognised journals and conference proceedings. Among these, Infacon and Molten Slags, Fluxes and Salts Conference series should be mentioned. The studies from a fundamental point of view include thermodynamic, phase equilibria, transport phenomena,

kinetics, and process dynamic aspects of high temperature processes and systems, both in the solid and liquid states.

RECENT PAST

From the early 1970s to the 1990s, there has been an increasing demand for more skilled and specialised metallurgical engineers who are either process or materials oriented and able to respond to the varied requirements of industry. In the 1970s, the curriculum was split into two options: Minerals Processing combined with Extractive Metallurgy, and Physical Metallurgy and Corrosion. In the 1980s, the Fracture Research group was formed, and, in the 1990s, alloy development and materials processing activities increased. At the start of the 21st century, again following industry trends and new thrusts in education, the department changed its curriculum from option-based specialisation to an integrated outcome and skills-based generic metallurgical engineering degree. It is based on processing principles and materials behaviour. This approach was given a strong structural boost by the formation of the School of Process and Materials Engineering (PRME) at Wits, the product of the merger of the departments of Metallurgy and Materials Engineering and Chemical Engineering under one umbrella in 1995.

PRESENT

During the second half of the 1990s, the Metallurgy Department pioneered the formation of the Centre for Materials Research and Education (CMRE), tasked with promoting and coordinating all the materials-related research activities at Wits. This resulted in a huge increase in research activities, especially in the field of hard metals. On the education side, due to the fact that the undergraduate curriculum formed the basis for generic, multi-skilled, fundamentally oriented metallurgical engineers, specialisation shifted to postgraduate programmes. The department once again reacted to the requirements of industry by introducing course-based Master's programmes in Coal Studies, Pyrometallurgy, Materials Engineering, Welding Engineering, and Minerals Processing and Extractive Metallurgy. Moreover, the undergraduate curriculum has recently undergone revision, with the inclusion of some non-technical subjects to produce even more socially aware and responsible metallurgical engineers. Research activities continue in pyrometallurgy, minerals processing, materials processing, corrosion, hard metals, ceramics, and alloy development. Almost all of the individual research projects leading to master's and doctoral degrees are industry funded, as are most of the undergraduate fourth-year projects.

'The School of Chemical and Metallurgical Engineering' became the official designation of the school in 2005, when this was ratified by the university council. Over the past year, members of staff and students presented papers and posters at 12 local and 38 international conferences, colloquia, and symposia. A total of 32 papers and 18 refereed conference proceedings were published, and resulted in 21 research output units for subsidy purposes. A

total of 60 undergraduate students, 6 MEng, 8 MSc(Eng), and 6 PhD students graduated and received their degrees.

FUTURE

The future is hard to predict, especially with respect to financial uncertainties that universities are faced with. Nevertheless, Wits Metallurgy is well placed to continue its efforts in both teaching and research with a group of well-established researchers and some young developing academics. The team is very enthusiastic, efficient, and dynamic. They are prepared to go all the way to serve the needs of the society and industry, by leading rather than reacting.

CONCLUSIONS

A hundred years of success and excellence is not only something to be proud of, but something to build on further with all the lessons learned. It is clear that the value to South Africa of academic learning at an undergraduate and then at a postgraduate level, especially in metallurgical engineering, has been tremendous. We have moved from mostly imported science and technology to become a significant supplier of world-class engineering services and products in a number of areas related to the metallurgical industry, such as the electric furnace smelting of platinum group metals, ferro-alloys, light and refractory materials, and development of manganese-containing stainless steels.

Wits Metallurgy has significantly contributed to all the above, in terms of human resources, by producing competent graduates, and in terms of fundamental research, leading to the development of relevant technology. This is an ongoing effort. Exciting future opportunities are emerging in the development of new industries and the expansion of existing ones. There is no doubt that Wits Metallurgy will continue to contribute to the well-being of this country and the industry during its second century.

REFERENCES

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