THE INDUSTRIAL APPLICATION OF POWER CONVERTERS IN MECHATRONIC SYSTEMS FOR CONTROL OF VIBRATORY CONVEYING AND DOSING OF PARTICULATE MATERIALS

The vibratory conveying is widely applied in many industrial technological processes involving gravimetric transport, processing, and dosing of particulate and granular materials. From the macroscopic point of view, the process of vibratory conveyance is based on recurrent micro-throws of particles of the material being conveyed. Vibrations of the load (vibratory trough), i.e. of the carrying element, the so called load carrying element (LCE), containing the material cause movement of particles of the material, therefore the material obtains the character of a viscous fluid and as such becomes suitable for conveyance, dosing, or further processing. The conveying material flow directly depends on the average value of particles throw movements, being on a certain LCE working vibration frequency. This average value, on the other hand, depends on *vibratory width* i.e. doubled amplitude oscillation, of the LCE. Optimal transport is determinated by drive type. It is within frequency range $5Hz-120Hz$ and vibratory width range $0.1mm-20mm$, for the most of materials. Different drive types can achieve mechanical vibrations of the conveying element. The very first drives were originally completely mechanical (pneumatics, hydraulics and inertial). Nowadays, most of the common drives are based on mechatronic devices (i.e. mechanical and electrical). When a reciprocating motion has to be electrically produced, the use of a rotary electric motor with a suitable transmission is really a rather roundabout way of solving the problem. It is generally a better solution to look for an mechatronic incremental-motion system with magnetic coupling, which produces a direct "*to-and-from"* movement. By realizing free vibrations of variable intensity and frequency over a wide range through application of the vibratory conveyor, electromagnetic actuator, suitable power converter, and the corresponding controller (which together makes up a complex mechatronic system), continuous conveyance of granular materials have been provided for various operating conditions. Standard power output stages intended for control of vibratory conveyance using thyristors and triacs. Phase angle control can only accomplish tuning of amplitude oscillations, but oscillation frequency cannot be adjusted by these converters. Switching converters overcomes these disadvantages. Application of current controlled transistor converters enables accomplishing the amplitude and/or frequency control. Their use implies the excitation of a vibratory conveyor independent of the supply network frequency. In addition, the frequency control ensures operation in the region of mechanical resonance. Operation in this region is favourable from the energy point of view, since it requires minimal energy consumption. As well as, amplitude and duration of excitation force tuning, it is also possible to tune its frequency. Consequently, complicated mechanical tuning is eliminated and seeking resonant frequency is provided. In the lecture will be presented a possible solutions and advantages of the amplitude and (or) frequency control of vibratory conveyors by means of different power converter topologies, as well as some further directions of development and application of power converters in this mechatronics systems. Also, the lecture will show the retrospective of realized industrial solutions of vibration transport that was applied in the process industry, the cement industry and in the systems for transportation of slag and ash on thermal power plants.

Key words: *Vibratory conveying, mechatronics, power converters, current control, resonance, vibration control, energy efficiency.*

LECTURER: Željko V. Despotović, PhD.E.E, IEEE Senior member,
Mihajlo Pupin Institute, University of Belgrade, Serbia

Željko V. Despotović, PhD.E.E- Short BIO

Željko V. Despotović was born in Prijepolje, Serbia. He finished primary school and high school in Nova Varoš, Serbia, 1979 and 1983, respectively. He received the B.Sc.(dipl.ing), M.Sc. and Ph.D. degrees in School of Electrical Engineering (Chair of Power Converters and Drives), from the University of Belgrade, Serbia, 1990, 2003 and 2007, respectively. He has been with the Department of Mechatronics, Mihajlo Pupin Institute, Belgrade, since 1991. His research interests include the fields of power electronics, mechatronics, power converters control, vibration control and control of vibratory conveying systems. His currently positions in Mihajlo Pupin Institute are: Associate Research Professor and Head R&D Engineer of Power Electronics. During his scientific research and professional work, he has led a number of significant research and development and scientific projects of interest to the electric power industry, process industry and water management. During his scientific research work was deal with the following areas: design and control of power converters, control of mechanical systems and mechanisms, hydraulics and hydrodynamics systems, control of vibrations and development of industrial controllers.He has published 15 papers in leading international scientific journals, 80 papers at international conferences, 30 papers in leading national journals and more than 50 papers at national conferences. He is the author of many technical solution and realizations of industrial prototypes (more than 70 technical solutions and more than 30 industrial prototypes). He participated in a number of international and academic projects, as in scientific and investment national projects. It has a Graduate Engineer's Licenses (Serbian Chamber of Engineers): 352-*Responsible Designer of Electrical Drive Control - automatic, measuring and regulation* and 350-*Responsible Designer of Low and Medium Voltage Power System*, Serbian Chamber of Engineers. He participated as a designer and as responsible designer, on more investment project (more than 50 projects). He is professor at the School of Electrical and Computer Engineering of Applied Science - Belgrade, Serbia, since February 2010. He is professor at PhD academic studies on the School of Electrical Engineering, University of Belgrade-Chair of Power Converters and Drives (teaching courses: Power Converter, Control of Power Converter), since 2014. He is IEEE senior member, since 2015.

Contact details:
PhD.E.E Zeljko Despotovic
IEEE Senior Member,
Associate Research Professor
Mihajlo Pupin Institut, Volgina 15
Belgrade 11060, Serbia
Tel.: +381 11 6771024
Mob.tel.: +381 63 331645
Fax: +381 11 6776 583
E-mail: zeljko.despotovic@pupin.rs
URL: http://www.pupin.rs/en/cv/zeljko-despotovic/