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## Process engineering development for the manufacturing of manganese octoate on a pilot plant scale

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### ABSTRACT

A technically and economically feasible process is developed for the manufacturing of manganese octoate as a powerful paint drier in a pilot plant unit. Such material is an environmentally safe through drier, catalyzes cross linking within the whole coating layer and is highly recommended for both hard and durable finishes. Scaling-up is based upon successful studying, evaluation and optimization of all operating parameters affecting process chemical reaction kinetics, product recovery and purification, and finally the vacuum crystallization stage. The performance of the pilot unit, overall conversion of reactants (>85%) were in excellent conformity with laboratory results.

Full characterization of the final product is accomplished through practicing a variety of instrumental XRF, FTIR, XRD, ED-XRF, elemental and HPLC analyses. The developed product has been used in different commercially practiced formulations proved excellent drier characteristics including adhesive strength, film hardness and ductility.

The design capacity of the pilot plant could match excellently with local commercial market demands that depend on price–consumption rate relationships. The process techno-economic evaluation reveals high profitability potentials including % annual return on investment and payback period.

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### 1. Introduction

Although used in small amounts, paint driers have specific functions and play a very important role in the final quality and properties of alkyd paints. Without their addition, the drying of alkyd paints would be too slow for most practical applications (Bieleman, 2000). Typical driers for alkyd systems used in decorative paints are metal salts of long chain fatty acids (soaps) according to the formula  $(M^{n+})(X^-)_n$  in which M is a metal (V, Mn, Fe, Co, Ce, Ca, Zr and Pb), and X is a synthetic C<sub>6</sub>–C<sub>18</sub> aliphatic carboxylate. Typical carboxylates are branched monocarboxylic acids such as 2-ethylhexanoic- and neodecanoic-acids.

Primary and secondary driers affect the drying rate by interacting with transition metal driers and reinforcing the 3-dimensional polymer network by interacting with hydroxyl and carbonyl groups of binders via formation of oxygen-metal-oxygen bridges (Bieleman, 2000; Landau et al., 1979; Turner,

1986; Erich et al., 2006a,b). The metal part is responsible for drying and catalytic actions, while the acid portion influences the physical properties.

Cobalt driers are the most active primary driers in both solvent- and water-born paints (Gorkum and Bouwman, 2005; Land et al., 1971; Tanase et al., 2004). However, a disadvantage of Co-based driers is that their catalytic activity in air drying coatings and paint compositions diminishes upon standing. The decrease is worst in waterborne systems (Hurley and Buono, 1982), being ascribed to hydrolysis of metal carboxylates and/or adsorption of the drier on the surface of the pigments. Another disadvantage is their suspect toxicity (carcinogenicity) to tissues and lungs (Micciché et al., 2005; European Commission, 2003; Lisbon et al., 2001; Bucher et al., 1999; De Boeck et al., 2003; Bieleman, 2002; Danish EPA, 2002). As a consequence, in the near future more stringent environmental legislations will force the paint industry to replace Co-based driers with environmentally friendly alternatives

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