# A Comparison of Numerical Search Methods for Optimization of Particle size Classification Process at Esfordi Phosphate Plant

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## ABSTRACT

Hydrocyclone is one of the most important equipments for efficient separation of fine particles in mineral processing industry. Due to high usage of hydrocyclones in closed grinding circuits, optimization of these devices will directly affect the whole operation efficiency. Finding the optimum steady-state values of hydrocyclone's design and operating parameters in order to achieve the process targets requires application of simulation and numerical optimization methods. In this paper, optimization of the primary hydrocyclone in ball milling circuit of Esfordi phosphate plant was done by BMCS simulator in Matlab environment. In this software, Simulation of hydrocyclone is based on Plitt's model which was used by GA and Pattern Search (PS) Toolboxes in Matlab software for solving the optimization problem. To search for optimum operating condition, first the target function was defined according to the desired particle size distribution of hydrocyclone underflow stream set by plant process engineers. Then, repeated simulations of hydrocyclone operation were done by BMCS under Matlab with automatic changing of input variables by GA and Pattern Search Toolboxes. The search results are considered to be the optimum values of the variables. The results obtained from these methods showed that GA method is a more powerful tool than PS method to determine the optimum steady-state design for new or existing plants.

Keywords: Hydrocyclone, Optimization, Genetic Algorithms, Pattern Search Method, BMCS

## Introduction

Optimization techniques target improving plant performance through better utilization of energy and equipment. In plant operation, optimization leads to better yields of valuable products (or reduced yields of contaminants), reduced energy and reagent consumption, higher production rates, and fewer shutdowns. Optimization can be effected by applying off-line (circuit analysis and simulations) or on-line (manual or automatic control strategies) techniques. Optimization can be limited to a particular segment of a plant (local optimization), or it can be at plant scale (global optimization).

Mineral processors are increasingly using computer simulations to assess the effect of changing critical process variables such as fresh flow rate, % solids, grinding media size and ore grind ability on the circuit performance.

In mineral processing plants, generally the optimization is done on comminution circuits containing crushers and mills and classification systems. Sieves, hydrocyclones and air separators are mostly used classification systems. Adjusting the cut size of classification systems by optimization leads to lower circulating load, reducing the overgrinding and so, optimized performance of grinding circuit.

Recent advances in computer hardware and software allowed researchers to develop new search strategies to be used in function optimization problems. Therefore, it is now possible to better integrate optimization algorithms into simulation packages. Gradient search is one of the mostly used algorithms in numerical optimization tools.

Combining process simulation and numerical optimization algorithms provides a more powerful tool for mineral processors to find the best circuit design and operation parameters.

In this project, the results of optimization of primary hydrocyclone by combination of simulator algorithm with Genetic Algorithm (GA) and Pattern Search (PS) and