# Design of an Expandable Base Pipe Using a Genetic Algorithm-Based Multi-Objective Optimization Method

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*Abstract: Perforated base pipe is an important component in a completion system. Field applications dictate that a good perforated base-pipe design should have good expandability and good post-expansion tensile strength and collapse strength. High fidelity FEA models for evaluation of expandable base pipes have been developed; however, to optimize hole pattern design (size, shape, placement pattern) of a given size base pipe, even numerically, can be expensive and time consuming. Using FEA models and a genetic algorithm-based multi-objective optimization scheme, the authors have successfully optimized a perforated base pipe in a relatively short period of time. The significant improvement over standard design has been demonstrated by physical tests. Several aspects of the optimization process will be presented in this paper.*

*Keywords: Expandable completion, basepipe, expansion, optimization, constraint, genetic algorithm*

## 1. Introduction

The expandable completion system discussed in this paper provides a means of improving sand-control completion functionality and complements the existing sand control technology portfolio. It uses perforated and solid expandable base pipe with easy and quick connections, superior filtration material, and unique annular barrier technology. The expansion is realized via hydro-mechanical expansion methodology. See **Figure 1** (Echols, 2002). The perforated base pipe with filtering material forms a sand screen with the main functions of limiting sand mobility within the formation, minimizing the occurrence of borehole collapse, and facilitating production control. Therefore, the perforated basepipe is an important part of this system. Field applications dictate that a good perforated basepipe design should have good expandability and good post expansion tensile and collapse strength. In this paper, the focus is on the numerical optimization of the design of perforated base pipe.

Finite element simulation of the expansion of perforated base pipe has become a standard practice in the design of expandable systems. Due to the strong nonlinearity involved, the computation is typically intensive, and takes a relatively long time. This prevents effective application of FEA in large scale optimization of the perforated base pipe. Instead, the authors use surrogate model ensembles for sparse data (Chen, 2007) to achieve a true design optimization based on limited FEA simulations.

The discussion in the paper is organized as follows:

1. *Section 2* — simulation of base pipe expansion
2. *Section 3* — the optimization technique
3. *Section 4* — aspects of design optimization
4. *Section 5* — concluding remarks.

## 2. Simulations for Design of Expandable Perforated Base Pipe

For a given size of perforated base pipe, the main design parameters that influence its performance include selection of materials (ductility, fracture strength, corrosion resistance etc., typically determined a priority between designers and metallurgists), expansion-cone design, and hole design (size, shape, placement