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Some Applications of Simplex Method

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***Abstract*: In this review paper simplex method and its application is discussed. The simplex method has played a vital role during these many years in many real world problems and still the simplex method are improving in order to get the optimum solution .There are many application but a total of three application are taken which describes the implementation of simplex method and its computational advantages with examples. It is one of the popular algorithm for linear programming [1].**

***Keywords:* Primal-Dual, Simplex method, Model predictive control, Dantzig's method.**

I. INTRODUCTION

Linear programming (LP) is an optimization method applicable for the solution of problems in which the objective function and the constraints appear as linear functions of the decision variables. Most real life problems when formulated as an LP model have more than two variables and therefore need a more efficient method suggest a optimal solution for such problems. George B. Dantzig, who was a member of the Air Force group, formulated the general linear programming problem and devised the simplex method of solution in 1947[3,4].This has become a significant step in bringing linear programming into wider use. The concept of simplex linear programming is considered a revolutionary development that permits us to make optimal decisions in complex situations.Simplex method is a iterative process but progressively approaches and eventually reaches optimum point[2].

The number of applications of linear programming has been so large.One of the early industrial applications of linear programming was made in the petroleum refineries. In general, an oil refinery has a choice of buying crude oil from several different sources with differing compositions and at differing prices. It can manufacture different products, such as aviation fuel, diesel fuel, and gasoline, in varying quantities. The constraints may be due to the restrictions on the quantity of the crude oil available from a particular source, the capacity of the refinery to produce a particular product, and so on. A mix of the purchased crude oil and manufactured products is sought that gives the maximum profit. The optimal production plan in manufacturing firm can also be decided using linear programming. Since the sales of a firm fluctuate, the company can have various options. It can build up an inventory of manufactured products to carry it through the period of peak sales, but this involves an inventory holding cost. It can also pay overtime rates to achieve higher production during periods of higher demand.

Although several other methods have been developed over the years for solving LP problems, the simplex method continues to be the most efficient and popular method for solving general LP problems. In this paper review and formulation of applications of simplex method is discussed.

II. REVIEW OF APPLICATIONS

Case 1:

In the first case optimization of sand casting is done by using the Dantzig's simplex method. This method is used to explore optimization of the sand casting parameters for the most favourable conditions.Aluminium alloys were cast and undergoes a series of mechanical test. Some process constraints and linear functions are formulated and utilize the simplex method for optimization of parameters and the results are used for studying performance of the parameters.Variation of casting properties is shown in Table 1 and Table 2[7].

Table1. Variation of casting properties with mould temperature

Pouring Temp (°C)	Solidification time (min)	Impact strength (J/mm2)	UTS (N/mm2)	Hardness (HRB)	Percentage elongation (%)
700	1.20	0.46	44.20	15.08	1.80
750	1.47	0.32	50.50	16.47	2.50
800	2.32	0.31	64.20	17.60	6.80
850	3.24	0.30	67.40	18.22	9.90

Case 2:

In the second case Primal –Dual Simplex algorithm is used for Solving Linear programming with trapezoidal fussy numbers. In the second case two methods are used for solving fuzzy linear programming FLP) problems using trapezoidal numbers without turning them to a crisp linear programming. This method is proposed by Ganesan and Veeramani[4].and the dual simplex is given by Ebrahimnejad and Nasseri[5].The primal method alone cant solve the problems as it has some loop holes in it and dual method doesn't gives the feasible solution so both the methods are combined that is primal-dual algorithm is applied to overcome the loop holes.

Case 3:

In the third case a problem is minimized in model predictive control by using a modified simplex method. In the third case minimization is done and method is applied to a polyhedron and in this the method is changed according to the problem and thus making the solution feasible and faster. The method skips iterations and its advantages are verified in the examples.

III. FORMULATION OF APPLICATION

Case1:

The simplex method solves the problem by converting inequalities into a linear programming and then solves by manipulation as this method is efficient and easy to implement in a problem. A number of different methods are used to solve the problems for the optimal result so the following subsequent paragraphs would make this method more clear that which is better compared to the other methods. There are five casting parameters (solidification time, impact strength, Ultimate Tensile Strength, hardness and percentage elongation) on the three variables (mound temperature, pouring temperature and runner size) which are requires for the preparation casting and moulding and graphs are also required in which deviation of different process parameters are measured which can be positive or negative and thus finally the one equation with three constraints are derived from the graph and table and the function is minimized by applying simplex method and the optimal solution is 0.392(solidification time) which is feasible according to the problem.

Case 2:

In the second case, the coefficients involved in the objective and constraint functions are not precise in nature and have to be interpreted as fuzzy numbers to reflect the real world situation. Thus the mathematical problem is therefore referred to as a fuzzy mathematical programming problem. Maleki et al proposed a simple method for solving fuzzy number linear programming (FNLP) problems. They also applied a special kind of FNLP problems, involving fuzzy numbers only in objective function, as an auxiliary problem. A certain linear ranking function to define the dual of FNLP problem as a similar problem that lead to an efficient algorithm called the dual simplex algorithm for solving FNLP problems. The concept of the symmetric triangular fuzzy number and an approach to defuzzify a general fuzzy quantity is applied in this algorithm.The new method based on the primal simplex algorithm for solving linear programming problem with symmetric trapezoidal fuzzy numbers without converting them to crisp linear programming problems. The primal simplex algorithm for solving linear programming problem with symmetric trapezoidal fuzzy numbers without converting them to crisp linear programming problems. Some concepts of fuzzy set is explained in this case and fuzzy primal simplex algorithm and also fuzzy primal dual algorithm which starts with a basic feasible solution for FLP but the solution is not feasible and so a new dual simplex algorithm has been developed to over the shortcoming by the duality. This algorithm starts with dual basic feasible solution and walks to an optimal solution by moving among the adjacent dual basic feasible solution. As a result a fuzzified version of conventional that primal-dual method is developed. An illustrative example is taken in which slack and fuzzy artificial variables are taken to minimize the function and gives the basic feasible solution. This process is time consuming and has no efficiency.

Case 3:

Lastly in the third case simplex method is used in minimization of a problem and formulated based on the some manners:

A new variable is introduced minimization of the sum is done.

By replacing each deviation by a difference of 2 non negative variables and then minimizing it

A modified simplex method has the following three objectives

1. Simplex method used to find the optimal point in a polyhedron that extends up to negative domain.

2. To skip the unnecessary steps thus avoiding any computational effort.

3. To formulate the problem as its initial basic feasible solution is available.

This method is presented for 1 norm minimization problem as it arises in model predictive control (MPC).The computational advantages of the method is verified by its application by using it in a examples.

Example 1: To enable the simplex method to find the optimal point in a polyhedron that extends into the negative domain.

The basic strategic is to use the simplex method in the usual manner on the section (portion) of the polyhedron that lies in the positive domain to locate the optimal point in this section. Then, if the search needs to go in the negative domain, flip the section of the polyhedron that is of interest into the positive domain and continue the search. The flipping can be accomplished by switching the sign of an optimization variable through redefinition. The slack variables are not allowed to switch. A record is kept of the switch status of the optimization variables to report their correct sign at the end of the solution. This is shown graphically in the paper.

Example 2: A open loop transfer function is taken and the results are computed by using a computer programs as there would be number of iterations and many parameters are compared by using different algorithms and thus this method uses a smaller number of steps and most modern control packages use this method to solve the optimization problem and many control system can be benefitted by using simplex method.

IV. CONCLUSION

In the case one the the below conclusions can be drawn The Dantzig's Simplex method can be adapted to casting process to explore optimization of some sand casting parameters for the best results

As researched with simplex method, the minimum deviation (ΔS) of the solidification time was obtained as 0.392, this is the minimum deviation from the ideal value that can be tolerated to achieve optimal combination of other factors to obtain a good product . Since a decrease in solidification time results in finer microstructure leading to improvement in the entire range of mechanical properties, the result from the model would practically imply that experimental solidification time can be further reduced whilst still obtaining a balance of other casting factors[7].

Thus in the second case a new approach based on primal simplex algorithm to obtain the solution of fuzzy linear programming with trapezoidal fuzzy numbers without converting them into crisp linear problem and is based on theinteresting results given by Ganesan and Veeramani[3].This method is expected to be reliable for solving minimum cost flow with fuzzy parameters in which finding s initial dual feasible solution turns out to be a trivial task[8].

In the third case thus by using the simplex method we can find the optimal point in a polyhedron that extends into the negative domain. Thus the need to increase the size of the LP problem to bring the entire polyhedron into the positive domain is eliminated.The unnecessary iterations in the search can be skipped. The modifications presented can also be used in problems other than the 1-norm minimization problem.The modified simplex method offers a significant computational advantage over the conventional formulations for the solution of 1-norm minimization problems[9]

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