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Selection of die punches material for optimum design

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ABSTRACT

With the availability of a large number of materials and to fulfill the requirements of the manufacturing industries, material selection today becomes a quite complicated task. The designers have to think twice before selecting the best suitable material for a specific engineering application. Improperly chosen material may occasionally shorten the product's life, while leading to unnecessarily increased product cost. Before arriving at the best material selection decision, the designers have to clearly understand the requirements for the product and shortlist the available material alternatives based on their performance in meeting those product requirements. To guide the designers in selecting the best alternative for a specific engineering product, there is a need for a systematic and structured mathematical approach. The material selection problems with multiple non-commensurable and conflicting criteria can be efficiently solved employing multi-criteria decision-making (MCDM) methods. In product design material has been selected for the die punches on the basis of past experience and available material and properties of that material. No optimum material selection method available in product design. To overcome this problem it is necessary to develop optimum methods for the die punch material selection. For ranking the die punch materials the multi-criteria decision-making (MCDM) methods will be used.

Keywords— Material Selection, multi-criteria decision-making (MCDM) methods, Screening, Ranking.

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I. INTRODUCTION

Materials have been extensively studied in science and engineering for years. Existing materials selection source scan serve as useful function in giving up to date information on the technical (physical, quantifiable) aspects of materials. Design of an engineering component involves three interrelated problems selecting a material, specifying a shape, and choosing a manufacturing process selection of material procedures can be used to select optimum materials and processes for a given component.

A. The Strategies of Material Selection:

Engineers make things. They make them out of materials. What do they need to know to choose and use materials successfully? First, perspectives of the world of materials – the "menu" of metals, polymers, glasses, ceramics, composites and so forth – and of processes that can shape, join and finish them. Second, some understanding of the origin of these properties and of the ways that they can be manipulated. Third, they need methods for selecting from these menus the materials and processes that best meet the requirements of a design. Fourth, they need access to data for material attributes and – since the quantity of data is large and the methods tedious to implement by hand – computer-based tools to enable their implementation. And, of course, they need common sense: the ability to use experience and knowledge of the world at large to recognize inspired choices and to reject those that are impractical. Selection involves seeking the best match between the property profiles of the materials in the universe and that required by the design.

a. Translation :

The first task is that of translation: converting the design requirements into a prescription for selecting a material and a process to shape it.

b. Screening: constraints as attribute limits

Unbiased selection requires that all materials are considered to be candidates until shown to be otherwise, using the steps in the boxes below “Translate” The first of these, screening, eliminates candidates that cannot do the job at all because one or more of their attributes lies outside the limits set by the constraints.

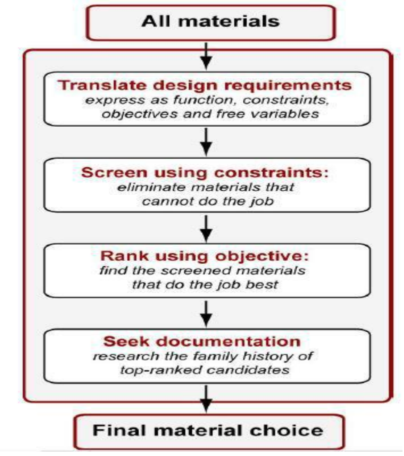

Fig. 1 the strategies of Material Selection

b. Screening: constraints as attribute limits:

Unbiased selection requires that all materials are considered to be candidates until shown to be otherwise, using the steps in the boxes below “Translate” in Figure 1.5 The first of these, screening, eliminates candidates that
a. Multiple Attribute Decision Making Approaches:

In contemporary researches, the performance of materials is evaluated against multiple criteria rather than considering a single factor. The selection of an optimal material for an engineering design or manufacturing process from among two or more alternative materials on the basis of two or more attributes is a multiple attribute decision making (MADM) problem. The decision variables can be quantitative or qualitative. A number of these attributes can be expressed as numbers, like density or thermal conductivity; some are boolean, such as the ability to be recycled; some, like resistance to corrosion, can be expressed only as a ranking (poor, adequate, good, for instance); and some can only be captured in text and images.

1 TOPSIS

2 ELECTRE

cannot do the job at all because one or more of their attributes lies outside the limits set by the constraints. As examples, the requirement that “the component must function in boiling water” or that “the component must be transparent” imposes obvious limits on the attributes of maximum service temperature and optical transparency that successful candidates must meet. We refer to these as attribute limits.

c. Ranking: objectives expressed as material indices:

To rank the materials that survive the screening step we need optimization criteria. They are found in material indices. A material index measures how well a candidate that has passed the screening steps can perform, that is, meet the objective. Performance is sometimes limited by a single property, sometimes by a combination of them**.**

d. Documentation

The outcome of the steps so far is a ranked short-list of candidates that meet the constraints and that maximizes or minimizes the criterion of excellence, whichever is required.

C. Method of Material Selection:

The selection of the suitable material is a difficult process that demands the management of a great amount of information about the materials properties and there are often several solutions for a particular application. After narrowing down the field of possible materials via one or more of the initial screening methods described in the last section, ranking methods can be used to further narrow the field of possible materials to a few optimum candidates. MCDM methods divide to two main groups, multiple objective decision making
(MODM) and multiple attribute decision making (MADM) approaches.

3 Analytical Hierarchy Process (AHP)

4 Simple Additive Weighting Method

5 Limits on Properties Method

6. Individual Methods -Compromise Ranking Method or

VIKOR

b. Fuzzy Multi-Criteria Decision-Making Methods:

For material properties like corrosion and wear resistance, machinability and weldability, numerical values are rarely given and materials are usually rated as very good, good, fair, poor, etc. For example, some of the important attributes of tool steels are non-deforming properties, safety in hardening, toughness, wear resistance and machine ability.

c. Multiple Objective Decision Making Approaches:

The material designer should then make a compromise among the objectives to come up with the best solution. Unlike the exact sciences, where there is usually only one single correct solution to a problem, materials selection and substitution decisions require the consideration of conflicting advantages and limitations,

1. Multi-Attribute Utility Analysis

2. Goal Programming

3. Genetic Algorithm and Neural Network

4. Individual methods in MODM

d. Optimization Methods:

Extensive optimization approaches have been proposed for material selection, such as mathematical programming, computer simulation, and genetic algorithm.

1. Mathematical Programming

2. Computer Simulation

3. Genetic Algorithm

D. Die Materials:

Tool steels are used to construct the die components subject to wear. They are used in a variety of press working operations. These steels are designed especially to develop high hardness levels and abrasion resistance when heat-treated. The plain carbon and low-alloy steels are readily machinable and weldable. These low cost steels are used for machine parts, keys, bolts, retainers, and for support tooling. Cast-steel dies are used for large drawing and forming dies where maximum impact toughness is required. At carbon levels of 0.35% and higher, cast-alloy-steel dies can be effectively flame-hardened at points of wear.

Cast irons are a plural term for cast iron because many different compositions having special properties are used for shoes, plates, dies, adapters and other large components. Die irons are often alloyed to permit flame hardening when used for the wear surfaces of large sheet metal drawing and forming dies. The ductile (nodular) irons retain the casting advantages of cast iron, while having toughness, stiffness and strength levels approaching those of steel.

II. PROBLEM DEFINITION

In product design material has been selected for the die punches on the basis of past experience and available material, cost, functional requirement and mechanical properties of that material. For the die punch material selection no material screening and material ranking method is used and no optimum material selection method available in product design of die punch material.

necessitating compromises and trade-offs; as a consequence, different satisfactory solutions are possible. In designing the component, the designer has a purpose; to make it as cheap as possible, or as light, or as safe, perhaps. This must be achieved subject to constraints: that the component can carry the given loads without failure, that certain dimensions are fixed, and that its cost is within certain limits.

In addition to ferrous die materials, varieties of die components are made of non-ferrous metals such as zinc and copper alloys. Elastomer products find widespread application as die pads, rubber springs and automation components. Even wood and wood fiber products are used for low-cost dies.

a. Choosing Tool Steels:

The wise choice of tool steels is important when dies are designed in order to insure good wear performance. Specifying more costly tool steel than is justified by die wear requirements is wasteful. Expensive die details should be designed for long wear. Likewise, die parts that wear rapidly requiring downtime for replacement and high repair costs should be designed for good wear resistance. The die repair activity should carefully track die repair costs as an aid to achieving the most cost effective tooling material and processing methods. This information should be used to update the die standards for each type of tooling. In this way, tooling dependability can be continuously improved and costs minimized.

1. Water-hardening Tool Steels

2. Oil-hardening Tool Steels

3. Air-hardening Die Steels

4. High-carbon High-chromium Die Steels

5. Shock-Resisting Tool Steels

6. Tungsten and Molybdenum High-speed Steels

7. Low-alloy Tool Steels

8. Hot Working Steels

9. Other Steels Used in Tooling.

III. OBJECTIVES

This project work will relate to finding the best suitable material for die punches by using screening and rankings methods:

a) Optimize alternative materials for die punch by choosing essential conditions of material.

b) To achieve optimum material and higher product performance.

c) Save the weight of material and reduce cost of material.

c) Select, verify with any supporting materials.

d) The materials that best meet the needs of the design, maximizing its performance and minimizing its cost.

IV. METHODOLOGY

Methodology consists of application of scientific principles; technical information and imagination for development of new or improvised punch material to perform a specific function with maximum economy and efficiency.

Following methodological approach has to be used in material selection for the punch die materials.

1. Measurement of important of punch materials in die of press tool.

2. Choosing alternative materials for punch.

3. By using screening evaluate large range of materials.

4. Objectives define performance metrics using rankings methods.
5. Select, then verify with any supporting materials.

A. Methods to Be Used:

Following multiple criteria decision making methods.

1. Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS).
2. Analytical Hierarchy Process (AHP).

3. Compromise Ranking Method or VIKOR

Eliminations and Choice Expressing Reality (ELECTRE).

III. EXPECTED OUTCOMES

Study of selection of material for die punches requires study of factors affecting material selection, material screening methods, and material ranking methods. This study is useful in following ways.

1. It will be useful for carrying the projects selecting best material process.

2. It will give some possible best alternatives for material die punch.

3. It will give some possible best screening method for material die punch.

4. It is also useful for Optimization of punch design.

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a Department of Mechanical Engineering, here knowledge is considered as the liable asset and it is proved that the power of mind is like a ray of sun; and when strenuous they illume.

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