MAINTENANCE POLICY FOR AGRIFOOD PLANTS

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Abstract

Life-cycle maintenance has been an important factor in modern agrifood companies competitiveness and has been attracting lately more attention in industry. The objective of maintenance is to reduce the number of unexpected breakdowns due to failures, which may be catastrophic and may occur huge loss. Many agrifood companies have shifted their maintenance programs to condition-based maintenance (CBM), which, if correctly and effectively implemented, can significantly reduce the maintenance cost.

Key words: condition based maintenance, policy, FMEA, HAZOP

INTRODUCTION

Trying to optimize maintenance can start with improving maintenance policy selection, which is, as already indicated, a non-trivial issue, especially, when having to consider characteristics as typical of process plants. Knowledge of plant structure, individual components, plant operation as well as organizational and economical factors are a pre-requisite for policy definition. Since it generally poses difficulty to human beings to keep such a multitude of aspects in mind at once, decision aids can be a valuable help facilitating, structuring, systematizing, objectifying and documenting the decision making process.

Many of the goals dealing with the selection of the best maintenance policy for equipment in an organization are non-monetary or intangible, which beside the monetary goals makes the selection problem more complex (Wang L., 2007). One of the tool used in order to determine the best maintenance policy ,,Fuzzy Delphi Method" (Fabricius S., 2003). In figure 1 (Jafari A., et al., 2008) is presented de decision tree for maintenance policy selection from goals perspective.

Must be created a maintenance manual with policies and practical guidelines to aid in defining appropriate maintenance strategies in different production facilities. In this manual, basically, a three step-process for maintenance definition must defined as :

1. Unit rating, indication whether pro-active or reactive maintenance policy is feasible.
2. A/E classification into categories "A", "B", or "C" (constituting a pyramid):

• "A": Critical A/E with respect to safety, ecology or quality; requires proactive measures stipulated by legal provisions or by internal guidelines

• "B": Critical A/E regarding economy and availability of the unit; justifies proactive measures for economic reasons

• "C": All other A/E not falling into categories "A" and "B"

3. Determination of pro-active measures for critical components.

The three steps is advised that to be completed in an interdisciplinary team effort and flow charts and checklists aid in the selection process. The manual also stresses the importance of investigating cost-benefit ratios of pro-active measures. It further emphasizes consideration for a variety of influencing factors, e.g., of how plant capacity is utilized, whether it is run 24 hours or only one shift per day. Such can have far-reaching implications for maintenance action definition and the maintenance manual encourages not only A/E investigation but also system (unit) - level aspects.

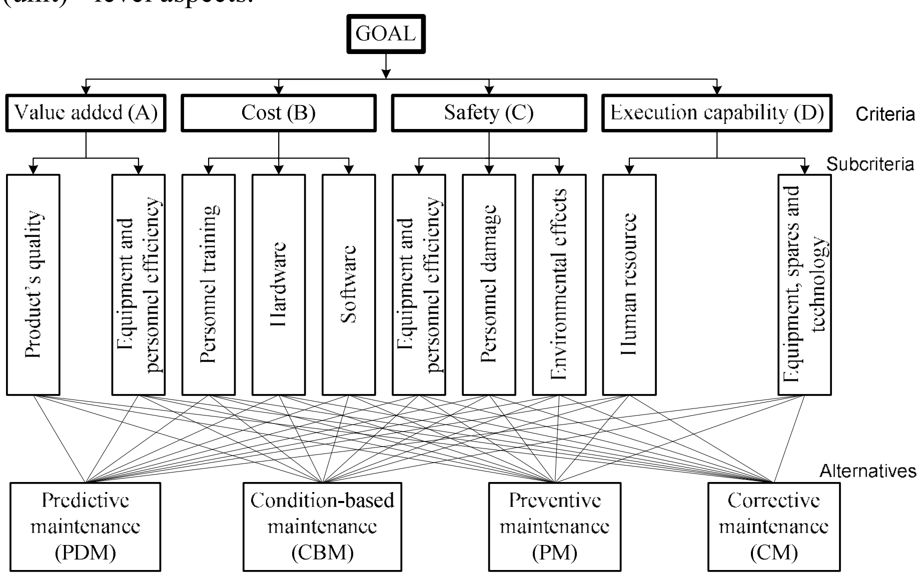

Figure 1. Decision tree for maintenance policy

MATERIAL AND METHOD

In complex agrifood process plant the three step selection process must be extended to nine steps, figure 2, (Fabricius S., 2003). The individual steps are further detailed, some containing sub-flow-charts or algorithmic statements in the form of structured text, descriptions, checklists and forms. This systematic selection procedure uses a process-oriented approach with consideration of operational aspects and costs involved and tries to help revealing systematic problems of the specific plant and its components with respect to maintenance. It is further characterized by treatment on different levels, namely on component, section, line and production building, with identification of individual component failure modes and consequences. In addition, inclusion of established analysis techniques as FMEA (Failure Modes Effects Analysis), HAZOP (Hazard and Operability Analysis) is encouraged.

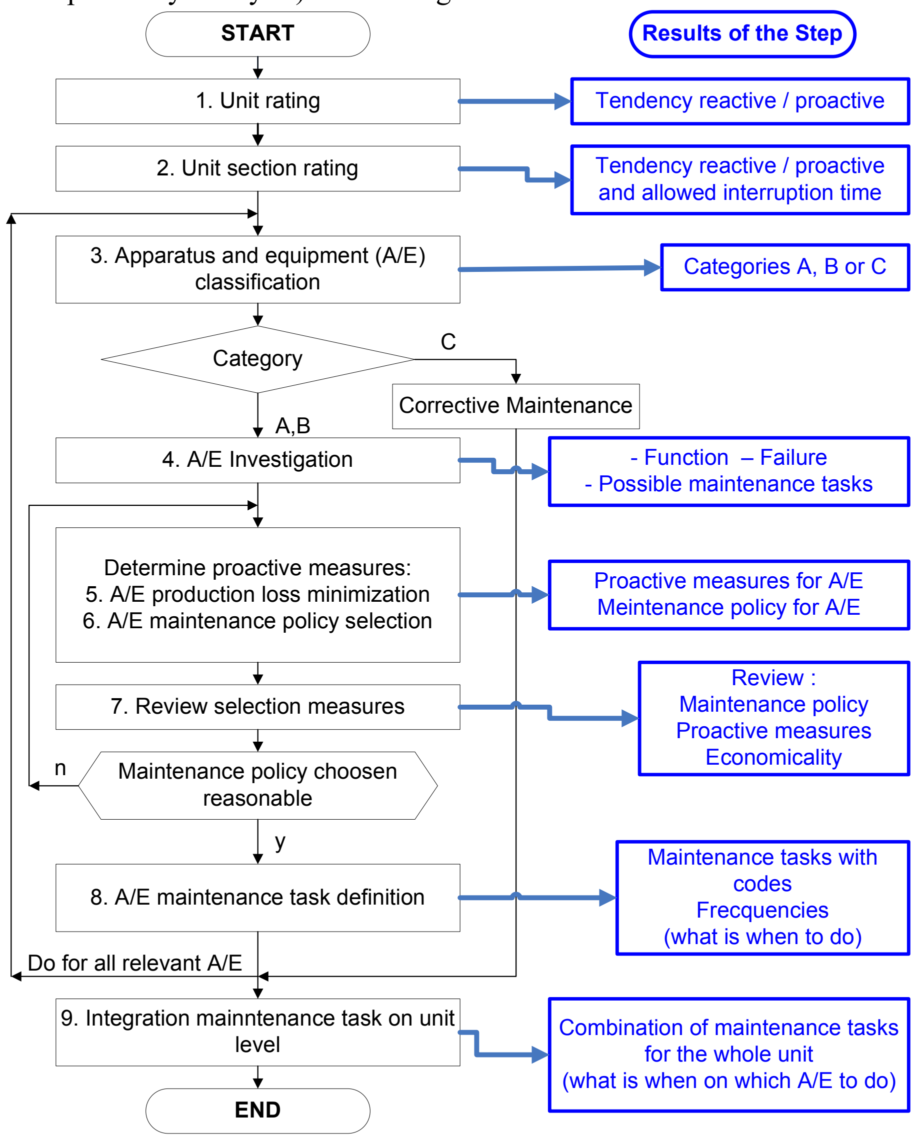

Figure 2. Top-level view of the nine steps for maintenance policy selection

The first step considers the whole production line. Availability demands are formulated for the line, depending on capacity utilization and consequences of production interruptions. New, is the section rating, in which the plant is partitioned in sections, according to plant topology with intermediate buffer tanks constituting section limits. Of importance are the throughput capacities of the defined sections and the BN (bottle neck) location. The basic idea behind this is to orient maintenance policy definition towards the process, including relevant aspects of plant dynamic behavior.

RESULTS AND DISSCUSIONS

The results of step one and two are a first hint of suitable maintenance policy for the unit and for the individual sections. The outcome mainly depends on the judgment of the persons carrying out the analysis steps, no mathematical model is used at this time. Step three is the classification of A/Es into categories "A", "B" and "C". In step four, functional requirements, potential failure modes with respective consequences and suitable maintenance actions are determined for A/Es belonging to category "A" and "B". Step four is quite similar to an FMEA, but focuses more on maintenance aspects; FMEA can be used complementary in the process. Maintenance policy indicates which maintenance tasks are to be carried out on what equipment at which points in time. Naturally — in order to define a maintenance policy — it is necessary to identify first the objects of a plant that need to be maintained. Plants can consist of a vast number of components, which can be surveyed with the help of computer programs. CMM (computerized maintenance management) systems or ERP (enterprise resource planning) software can provide functionality to manage maintenance objects, with algorithms to query and group them. Once the objects of interest to maintenance are registered, their functions, failure modes and maintenance actions can be analyzed individually or for classes of objects. Step five supports structured thinking (flow charts) about how production loss could be minimized.

In step six, maintenance policy type is defined on A/E level, figure 3 (Donca Gh., 2011) depicts a respective flow-chart. First, the failure modes (investigated in step four) and their respective repair times are addressed. This also involves estimation of relative frequencies of the different failure modes of an individual A/E. Second, the consequences of each failure mode at unit level are studied and formulated e.g., in terms of lost production hours per incident. Multiplication of the frequencies of the different failure modes with assigned hours of lost production gives an estimate of the contribution of an A/E to overall production loss. If the significance of the failure consequences is judged relevant (e.g., due to safety concerns), the failure behavior is further scrutinized. The flow-chart guides through a set of questions; finally, a suitable maintenance policy can be proposed. The procedure also includes elaboration on economic aspects and makes suggestions about spare part provision. During step six, classical methods as FMEA, HAZOP, FTA (Fault Tree Analysis) or ETA (Event Tree Analysis) can be deployed at convenience.

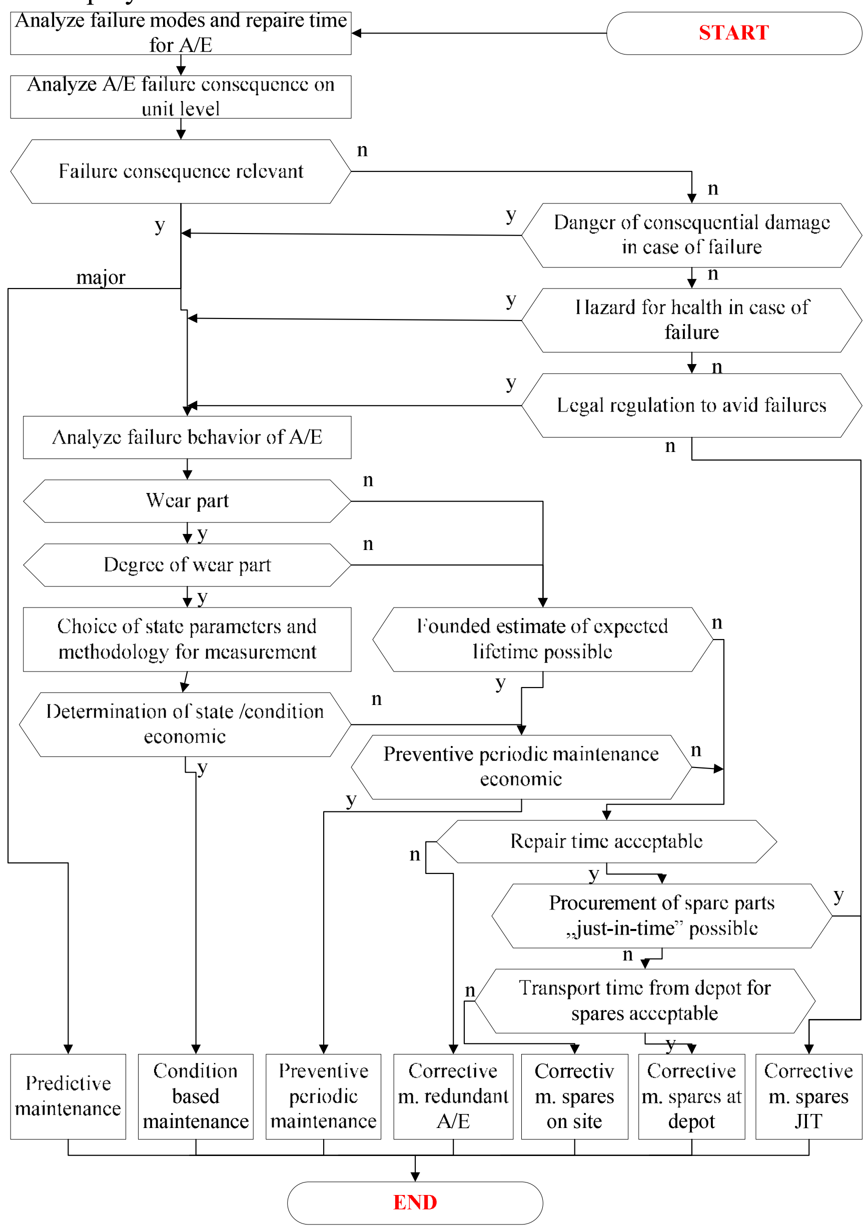

Figure 3. Determination of maintenance policy for A/E

CONCLUSIONS

The nine steps maintenance selection process contains many aspects of general applicability to all production facilities. A company can customize it, or not completing all of the nine steps thoroughly. The scheme can be flexibly adapted to a particular situation in a company at convenience. Since market conditions in process industry can change quickly, some A/E may be technically outdated within only a few years, or production facilities may be constantly being modified and improved. Often, decisions must be made based on incomplete, uncertain or qualitative information only. If this is the case, exact formal mathematical models are generally not very helpful in the decision process. Instead, a systematically structured, team-based, interdisciplinary approach — using a procedure as outlined in the nine step maintenance selection process — may be more feasible. Disadvantageous is the rather big demand with respect to resources, time, and costs when such an approach is followed. Since efforts to improve production efficiency are a continuous ongoing process in diverse areas, in practice it is hard to separate influence of new maintenance strategies from other contributing factors and to quantify resulting benefit. The data to make meaningful quantitative statements are often not (yet) transparently available, and the effects of changes may only be roughly estimated or seen over longer time intervals. Nevertheless, such decision aids can unify the selection process in a company, and allowing to profit from experiences across units. Broader analysis could be applied to particularly critical installations, and resulting conclusions could be drawn which may also be valuable to other related or neighboring plants.

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