BECKWITH MODULAR DIE ASSEMBLY

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INTRODUCTION

The Beckwith Modular Die (BMD)* is a new concept in the design and fabrication of a die orifice which can be used to cube alfalfa hay or other foliage crops. After about eight years of association; owning, operating and manufacturing parts; with cubing and cubing needs, we feel as though a die assembly has been conceived which offers many advantages. The first experimental unit was delivered in December, 1973, for installation on a Lundell stationary machine in Euphrata, Washington. The design concept is equally applicable to a Deere Cuber and a Lundell Cuber.

The BMD,* as will be understood when the reader continues, decouples, separates (isolates) the requirements which conflict, thereby, removing the dilemma of design compromises; hence, an optimal design may be used which enhances the advantages of cubing.

An engineering philosophy will be used to present and explain the concept which may be foreign to some.

REQUIREMENTS

Most macinery and/or parts may be considered from three basic requirements; functional, design and economical. Indeed, this philosophy may be projected into a number of areas when logical constructive thinking is needed.

Functional Requirements

Functional requirements may be interpreted as a statement or definition as to what exactly is the device needed for - what is it to do? In the case at hand - make cubes from alfalfa hay or other material which one may wish to interject into the machine. This is accomplished by providing a well regulated orifice with the proper surface finish so that the desired amount of heat is generated through friction and compaction. There are a number of designs patented and unpatented, which will accomplish the desired task; therefore, there is nothing unique about the BMD, considering this requirement.

Design Requirements

The design requirements may be divided into two paramount facets, mechanical integrity (strength) and environmental life. These requirements will be discussed separately and are the most important requirements to be decoupled (isolated). Without professing authority on the numerous concepts which have been conceived, whether patented, fabricated or marketed, the BMD concept is the only known concept which successfully decouples these requirements. Since more people are familiar with the Deere die design, no derogatory comment is intended, it will be used to illustrate the interrelationship of these two requirements. It might be added, that, the Lundell assembly has similar characteristics.

The compromise in the design requirements become apparent when one realizes that the die most commonly used must provide the mechan-

*Patent Pending

ical integrity (strength) needed to hold the die - right hand end cap - press wheel together against the forces needed to produce a cube. The resultant of these forces must be restrained by the material in the web of the die - particularly in that part of the web which is least prepared to constrain them, i.e., the tip or small end. This is also the portion which must provide resistance to wear, because, as the product enters the orifice, the largest portion of the work is done.

The other design requirement, which, is just as important, is abrasive resistance. A characteristic of most metals is that the harder the metal is heat-treated the more brittle it becomes and characteristics are obtained which are undesirable in an impact environment. It is possible to choose a metal which provides good abrasive properties; however, the strength properties for survival in an impact environment are compromised.

Economical Requirements

Yes, there are metals and processes available which will allow the fabrication of a better die - but, will it sell?? When choosing the metal, one must select one that is economically machinable and may be heat-treated for the desired hardness and strength. This condition suggests the use of industrial hard-chrome to obtain a surface hardness, but, remember there is an economical limit, as to the amount of chrome. The finish, at first thought, would seem to be a design requirement, but, is definitely an economical requirement, in that, a desired finish may be obtained on almost any surface if enough effort and money is expended.

DESIGN CONCEPT

Functional

After studying and understanding the three basic requirements delineated earlier, the design concept really becomes quite simple indeed. The question a designer must ask himself is how can the three requirements be met without any correlation between any two of them? The first requirement can easily be satisfied by proper fabrication tolerances and finishes. This is accomplished in the BMD by using precision machined slots in the wear plates to index each wedge, thereby, providing proper spacing and parallelism. The wear surfaces are ground to a finish better than 125 r.m.s. which gives the required smoothness.

Design

The second requirement - the one which conflicts in the presently used design may be decoupled (separated) by: using a hardened wedge to form the web part of the die; two wear plates which may be heat-treated quite hard to form the sides of the die and two support rings with strengthening ribs to provide the rigidity needed. The whole assembly is then bolted together with three exceedingly high tensile bolts through each wedge. It may now be seen that the hardened wedge with industrial hard chrome on its wear surface in conjunction with the two hardened wear plates on each side suffice to satisfy the abrasive requirements and the exceedingly high tensile bolts through the assembly binding the support rings together, suffice to satisfy the mechanical integrity requirements - each independent of the other, thereby, decoupling these two requirements.

That portion of the die which provides a track for the press wheel is realized by using two rails which also may be made quite hard by the proper choice of metal and processing. The rails are adjusted inward (together) as they are worn. Also they may be replaced independently from the rest of the assembly.

The present design consists of eight honey-combs made in 45° degree sections and may be replaced as a set or independently. A honey-comb consists of seven wedges with two side wear plates. The honey-comb is assembled at the factory and welded together. Each wedge is indexed by a shallow slot in the two wear plates. These shallow slots also provide a means of achieving ridgidity normal to the clamping of the bolts; thereby, preventing the wedge from breaking at the first bolt hole. It may be possible to fabricate the unit so that each wedge may be replaced independently; however, this idea must be proven experimentally.

It is felt that the forces present trying to separate (part) the assembly is not as great as these forces in a Deere machine because no end cap with small press wheel to end cap tolerances are used. Rather deflection plates mounted on the press wheel assembly which act as reverse augers deflect the product to the toe of the press wheels.

At this point an additional understanding of the design concept may be obtained by studying the accompanying figures.

Economical

For the entrepreneur, all requirements culminate into economical requirements - will the device suffice for his needs and reduce his cost? The BMD satisfies this requirement better than any known assembly available. By decoupling the strength requirements and abrasive requirements, the wear parts (replacement part) may be made as hard as desirable within available material bounds, thereby, increasing the wear life. History is not available to formulate any definite conjectures; but, our prediction is that a set of honey-combs should have twice the wear life as a set of presently used dies. This conjecture is based on two apparent conditions; 1) the wedge and wear plates may be made much harder than the wear portion of the presently used die and 2) there is about twice the amount of metal available to be worn away. The one experimental unit that has been in use in Washington has produced about 4000 tons and is good for at least 2000 more tons and the wedges were not chromed. It would appear at this time that the BMD assembly will reduce the die cost per ton to about one-half its present value. The advantages of the BMD to the cubing industry becomes more subtle where one is associated with obtaining the proper metal in large amounts for manufacturing the presently used die. A set of Deere dies weigh about 460 pounds and a complete replacement of honey-combs (eight) weigh about 180 pounds, approximately one-third. This results in a metal poundage saving and a freight saving. In addition, more latitude in the selection of metal is available, which allows the choice of more economical metals and enhances the availability in times of shortages.

An important facet which must not be overlooked is the versatility of fabrication to meet various usage requirements at no or little additional cost. It is easy to fabricate a die cell from 5½ inches to 8 inches long, with no additional tooling cost. Also, an inverse taper decreasing in orifice cross section radially, may be incorporated at no extra cost. The changing of these two parameters is not feasible with the present die design. This opens avenues for processing marginal alfalfa hay and other products, such as rye grass straw, etc..

MACHINE INTERFACE

The BMD is presently being manufactured in two sizes, 33.125"I.D. -56 wedges and 25"I.D.-45 wedges. Either size may be used on the Lundell machine.

The interface effort on the Lundell machine depends on which size is to be used. Each unit is designed with an adaptor ring on each end so as to match the required bolt circles. Using the 25" I.D.-45 wedge design presents virtually no interface problems - basically a bolt-on situation. The 33.125" I.D.-56 wedge design, however, requires the use of a new press wheel assembly which is available. The press wheel assembly has not been previously mentioned because it presents no new concepts. To use the larger design the auger flights must be extended to throw the product outward. It is felt that the retro-fitting necessary to encompass this new concept on a Lundell machine is trivial when the advantages are considered.

The interface situation on a Deere machine presents no problems. One paramount facet is that the Deere configuration is not compromised in any way: i.e., the Deere configuration may be reinstated at any time the owner chooses.

A different end plate for the auger tube will be needed, replacing the crank wheel, AE 24954. This new piece will mate with the crank extension, E 31597. It will have a shaft for press wheel arm attachment which is located about its center, thereby, allowing rotation about the center of the auger for the two press wheels which are diametrically located. This shaft will extend through into the self aligning bearing in the end plate - no end cap as is presently known. The length of the shaft will be chosen depending on whether or not a stationary unit or a field unit is to be used. The right-hand end cap will be replaced with a Lundell type end-plate, thereby, reducing or eliminating the friction present between the press wheel and the end cap.

For mounting; the Deere die ring, E 31638, is to be used so as to maintain the mechanical integrity of the auger housing. The mounting bolts will extend through the auger housing, bolt pattern existing, through the die ring into the adaptor ring which has been fabricated with a bolt pattern suitable for receiving the attachment bolts.

The new press wheel assembly with two press wheels is keyed to the shaft with diametrically located key ways and hubs. This provides a convenient means of adjusting the press-wheel-die assembly relationship. The deflection plates (reverse auger) are bolted onto the outer press wheel arm, thereby, allowing easy removal for accessibility and ease of machine unplugging. It's that easy!

SUMMARY

A die cell assembly has been conceived which meets all the basic requirements and provides versatility in usage. The assembly may be installed on presently available equipment with a minimal of interface problems and at a nominal cost. The present price structure suggests that the cost of a set of dies and a new press wheel will be about one-half the initial charge over cost.

Design knowledge and metalurgical characteristics indicate that the die cost per ton will be approximately one-half the present cost. By using a double press wheel configuration the production per hour should be increased because the hay is "hit twice per revolution".

We believe that this new concept will become a new generation in die cell design and offers many advantages to the cubing industry.