

Dwell Time and its Influence on Veterinary Tablet Production

Solid dose forms are a popular choice when administering medicine to animals. Conventional and chewable tablets are used to dispense drugs to dogs and cats, whereas modified-release boluses are given to cattle, sheep, and goats. The physical and chemical stability of tablets is generally better than that of liquid dosage forms and so are a popular choice. However, this popularity can bring with it problems with its manufacture.

There are many areas to investigate when producing tablets; dwell time is just one of them. Dwell can have a huge impact on tablet manufacture, whether that be for human consumption, or within veterinary medicine. Many formulations are sensitive to how this key element of compression is performed and the importance of this process is growing as the requirement for fast, efficient and fault-free tablet production becomes a necessity in modern manufacturing practices.

What is Dwell Time?

In order to produce tablets from granule/powder, it is necessary to use compression force; however, it is vitally important that the correct amount of force is used for the right amount of time. Too much, or too little of either, can result in tableting problems. Excessive force or over-pressuring of the punch can cause huge failure of the tool and will damage the press. For this reason, it is vital to understand how to optimise dwell time correctly.

Dwell time in the context of tablet compression is the amount of time each individual punch head flat is in contact with the compression roller(s) of a rotary tablet press, and that the compression force applied when forming the tablet is above 90% of its peak value. Key influences affecting dwell time include the punch head flat diameter and shape, use of pre-compression and RPM used during production. All these elements play a major factor on dwell and are often overlooked or misunderstood.

Dwell time plays a significant part in determining if a tablet can be produced successfully, especially those incorporating formulations that are challenging to compress. Not all formulations are dwell-sensitive as some will compress effectively at any speed; however, the majority are very susceptible to even the slightest change.

Formulation Characteristics

The characteristics of ingredients in a formulation can severely affect tablet manufacture, leading to common tableting problems which we will discuss below.

Plastically and Elastically Deforming

Many issues can be traced to the characteristics of certain ingredients in a formulation which display plastically or elastically deforming properties. The process of dwell time can affect the particles within the formulation being compressed.

Elastic deformation is a reversible process with particles regaining their original state once compression decreases. Particles which display plastic properties work in the reverse, with a permanent change to the particle shape taking place.

In cases of formulations with more time-dependant consolidation behaviour, a long dwell time is important to create strong bonds between the particles. When particles are subjected to a compression force for a longer period of time, further plastic behaviour is demonstrated, less 'spring back' happens, and this results in a more stable compacted tablet.

Sticking

A common problem encountered during tableting is sticking, which occurs when particles of the tablet formulation adhere to the punch face. Sticking has a negative effect on the appearance of the tablet and can become so serious that production can be interrupted, and in extreme cases, the punches may have to be removed to be cleaned. This is disruptive, labour-intensive, reduces yields and increases production costs.

Punch sticking occurs for a number of reasons and can occur unexpectedly during the development process or within production. Often an established product can run without issue and then a minor change in the manufacturing process or the formulation can tip the balance and sticking can start.

The first resort for tablet manufacturers is often to apply more compression force or to slow the press down to solve this problem. Either or both of these can often solve sticking but carry with them trade-offs in productivity and tooling/press lifetime.

Capping

The risk of capping or laminar separation can be caused when trapped air pockets appear in the forming tablet. If insufficient air escapes and/or density variations occur in the tablet, volume tensile strength is negatively affected, thereby heightening the risk and leading to severe problems during the manufacturing process. Employing tapered dies or using a press with a pre-compression stage are two common ways to overcome this problem. One of the most effective solutions available to tablet manufacturers is achieved by slowing down the press and extending the dwell time as it allows air to escape, but today's requirement for faster and more efficient tablet production makes this an undesirable option. Increasing the dwell time through other means is therefore the most desirable option. One example is through the use of tooling, which has been specially designed to achieve higher press speeds and enhance tablet compaction and cohesion, reducing the propensity for sticking and capping. Such tooling can increase dwell time by up to 50% over a standard punch head and removes the need for time-consuming and expensive press modifications.

Friability

Friability refers to the tendency of tablets to crack, chip or break during compression. This can be due to non-cohesive

characteristics within the formulation which fail to bind together adequately. By analysing key production factors including dwell time, weight control, expansion and the tooling condition, the possibility and impact of friability can be minimised to produce a quality tablet.

Moisture

All ingredients that are used in tablet manufacturing, whether active pharmaceutical ingredients or excipients contain differing moisture content. There are a vast array of formulations and each has varying characteristics therefore, moisture control during process becomes very complex.

Moisture often helps with the binding of the powder, or the compaction effect. However, if there is too much moisture, then the adhesive forces created between the granule and the punch tip face may be too great and can cause sticking due to capillary action.

Moisture can enter the process through either 'wet' granulate itself, or as a result of excess humidity in the compression chamber, formulation preparation and storage areas. It is therefore desirable that these temperature and humidity levels are controlled; however, this is not always possible.

In order to counter the problem of sticking due to excess moisture, it is important to utilise the optimum dwell time as it can have a significantly positive effect on the final tablet produced. Once calculated, the optimum dwell time can allow for the formulation's moisture content, without detrimentally impacting the quality of the tablet.

Summary

The veterinary medicine industry is predicted to see a huge development within the next five years with a growth rate of 8.1% according to research by Industry Today. This increase will bring with it a demand for tablets to be manufactured quickly and efficiently. This in turn will require new and innovative tooling and production procedures to be implemented to meet this growing demand.

Here we have looked at just one of the essential processes to consider during the manufacture of tablets. The crucial importance of extended dwell time can be illustrated by the frequent application of several techniques to increase the time that the punch is in contact with the compression roller, for example:

- Reduction of the tablet press speed in case of sticking, capping or insufficient hardness
- Installation of larger compression rollers to increase the total compression time
- Use of up-sized punches with a larger head to increase the size of the dwell flat.

These solutions are not always viable due to strict time constraints and budgeting, so other solutions are sought. The most practical answer is through the use of specific tooling that can be used without slowing the press, so production runs satisfactorily.

Specially designed tooling for increased dwell can do the following;

- Improve productivity
- Run on standard cams
- Solve dwell time problems without upsizing punches
- Allows faster press operation
- Enhanced tablet compaction
- A better quality tablet



With the help of an experienced tooling manufacturer and innovative new punches now on the market, tablet manufacturers can achieve higher press speeds with challenging products and formulations without the significant capital expenditure of a new press. One such tool is the elliptical extended dwell flat which achieves more dwell time without slowing down an existing press or upsizing punches, saving both time and money.

Involving a knowledgeable tablet tooling manufacturer is essential, especially as the requirement for veterinary medicine increases year on year. It is important to seek advice to ensure you are getting the best quality tablets at the best price.

REFERENCES

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Research, Development & Quality Systems Manager. Since joining I Holland in 2003, Rob has been instrumental in the development of a number of innovative additions to the company's product portfolio, including surface treatments and coatings for tablet compression tooling. With many years of experience within the pharmaceutical and nutraceutical industries, Rob uses his knowledge of tablet punches and dies, offering advice to tablet manufacturers on tooling configuration and procurement. He also co-ordinates all collaboration with academic research bodies and technical institutions to solve common problems found within the manufacture of solid dose forms.

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