Why release and application torques differ?

Twist closures are maybe the most common locking elements in the bottling industry. This description summarizes the context between the application and the release torques and highlights the most important factors that affect this context.

All this information concerns force-locking twist closures, where the maximum release torque is not affected by the warranty ring (as by the metallic ROPP closures or some plastic closure with locking warranty ring).

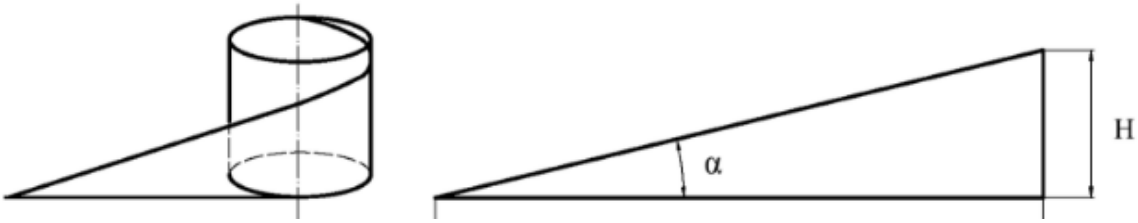
It is commonly believed that the release torque of a closure should be the same as the application torque. So the release torque of a closure applied with 15 LbIn torque should be 15 LbIn. This is not correct and there are several reasons for the deviation.

Release torque usually differs from the application torque, and it can be either lower or higher (and of course in some cases they can be equal too…). Let's look at the most important factors that affect the relation between the two torques. These factors can be grouped as:

- Physical parameters
- Size tolerance
- Dynamic factors

Deviation caused by physical parameters

- Thread geometry, especially thread pitch:



  - By higher thread pitch (bigger thread angle) the release torque gets lower than the application torque.
  - By flatter pitch it is possible that release torque exceeds the application torque (for comparison, remember the operation of the self-locking cones.)
- Top load applied by the capper – A capping head with the same application torque and higher top load may result different release torque.
  Application torque and top load builds a force system. Depending on the correlation between the vertical top load force and the application torque, the final application can be different. Example: same application torque with low top load can lead to bottle rotation, which influences both the application and the final release torque.

- Material and friction
- Type and geometry of the seal inside the closure (lip, liner, etc)
- Different shrinkage of the closure and container materials
- Elastic deformation of the closure with time (depending on storage temperature too)

These factors define and affect the relation between the application and the release torques. Of course at any specific container-closure combination the relation between the 2 torques is going to be approximately the same.

Deviation caused by size tolerance

A small deviation can always occur depending on the tolerance range of the container neck and closure thread's actual measures:

- Closure thread diameter in the upper side of the tolerance and neck thread in the lower side of the tolerance range will cause a looser connection
- Closure thread diameter in the lower side of the tolerance and neck thread in the upper side of the tolerance range will cause a tighter connection

The smaller the tolerance range of the closure and the neck thread is, the smaller the release torque deviation is going to be at the same application torque. This means that closures and container neck threads with smaller size tolerance result in more consistent release torques.

Deviation caused by dynamic factors

The speed of the closure rotation also affects the resulting/measured torque, as the dynamic impact of the rotation increases the static torque.

- Higher application speed will result higher application torque (with the same static torque setting on the capping head)
- Different release speed will result different release torque values too – the higher speed, the higher the measured torque gets.

Consequences of the dynamic effect:

- Changing the speed of the bottling line changes the application torque. It is advised to control the release torque at all usual line speeds and if necessary modify the capping head's torque settings accordingly.
- Consistent release torque testing speed results in higher consistency in the torque results. – In case of manual torque testing the results of the tests are also affected by the operator. Automatic torque testing eliminates the operator factor.

Deviation caused by dynamic factors

There are some other different factors too that may affect the resulted release torque, as:

- Cleanliness of the fill – There is a significant difference between wet and the dry torque.
  - Wet friction is lower than the dry friction
  - If product gets in the thread and dries there, that changes the friction too – think about sugar syrup!
- Quality of container finish: sealing land area – possible damages caused by during the process
- Capping equipment process control capability
- Storage conditions including temperature, relative humidity and static top load

We hope this abstract helps to understand a little more about the background of the twist closures application and release features. With any question or comment please feel free to contact us!