Blending Systems: Tastes Good – Just the Way it Should

The latest technologies for mixing beverages

by Gerhard Bohne

The manufacture of "near-water products" makes heavy demands on dosing technology. In the production of these beverages, relatively small quantities of concentrate are added to the conditioned water and must be blended with it homogeneously and in constant proportions.

Concepts for the manufacture of finished beverages

There are a variety of concepts for manufacturing flavoured waters. Apart from the traditional way of producing a beverage syrup (low-concentration syrup), it is also possible to manufacture a high-concentration pre-mix and then dilute it in a continuous in-line blending system. Alternatively, individual concentrates and pre-products can be blended directly.

Concept 1: Beverage manufacture using low-concentration syrup
With this concept, the batch mixer is used to produce a beverage syrup with a high water content. This syrup is then mixed with water in a two-component continuous blending system in a ratio of approximately 1:4 to produce the finished beverage. This concept requires relatively large mixing tanks downstream of the batch mixer. Thanks to the high proportion of water, it is possible to add all the concentrates to the finished syrup.

Concept 2: Beverage manufacture using high-concentration pre-mix
Due to the low water content, two separate pre-products (pre-mixes) have to be manufactured, as there are some concentrates that can only be brought together with each other when they are highly diluted. A batch mixer is used to manufacture the pre-mixes. These pre-products are then mixed with water in a three-component continuous blending system in a ratio of approx. 1:40 to produce the finished beverage.

Concept 3: Beverage manufacture by the direct blending of concentrates
A continuous in-line blending system for four to eight components is used to blend the finished beverage directly. Solids are dissolved in holding tanks that are connected directly to the blending system. Liquid concentrates and sugar solution are prepared in containers and also directly attached. Alternatively, liquid concentrates are conducted from bottles via holding tanks to the blending system.

With this concept the finished beverage becomes available more quickly, as the preparation time is less than with the other two concepts. If all the concentrates are available in liquid form and supplied in containers, the preparation time is eliminated completely.

Batch mixing equipment for making syrup / pre-mix

The batch mixer, controlled by the recipe, serves to produce pre-products for the first two concepts. The doses of several individual ingredients are introduced into mixing tanks one after another, and there mixed. Generally, two mixing tanks are assigned to the batch mixer, so that continuous supply to the downstream

Photo: IDM, Bonn

blending system can be achieved. While one tank is being filled with the product and stirred, the other tank is available to supply the continuous blending equipment. It is essential that the sizes of the tanks and the time sequences of the dosing procedures, mixing phases and analyses should be planned with precision, in order to ensure that syrup is available at all times.

The system consists of dosing lines for the partial emptying of concentrate containers, a dissolving tank for dry materials, an emptying station for bottles, a drum emptying station and two dosing lines for liquid sugar and water. Liquid concentrates from bottles and drums and dry materials have to be available in weighed-out amounts: these quantities are not metered by the system. Two containers with the same product are attached to each of the concentrate dosing lines; when one container is empty, the system automatically switches over to the second container. A common venting

lantern is used to determine when the product in one container is exhausted. This lantern also serves for testing the flow meter in the concentrate line.

The batch mixer works on the full hose principle. Before the start and after the ending of the mixing process, the whole pipe system as far as the mixing tank is filled with water. It is therefore possible to change the recipe immediately without any cleaning in between.

The recipe controls the filling of the dissolving tank with water, the predetermination of the necessary dissolution time and the emptying and rinsing out of the concentrate drums and of the bottle emptying station; concentrates from containers, sugar solution and water are dosed with high precision. The quantities of water required to dissolve dry materials and to rinse out the concentrate drums are subtracted automatically from the total quantity of water. If the Brix value of the sugar solution fluctuates, automatic density correction ensures the constant quality of the finished syrup.

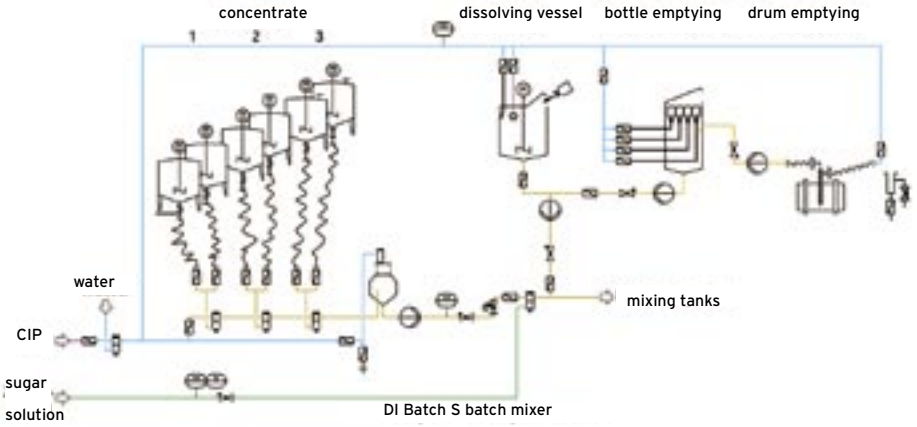
The dosing of concentrate, water and sugar solution is effected by means of a two-stage cut-off, the residual quantity being conveyed at a reduced flow speed. As a result, the after-running of product after the valves have been switched is substantially reduced. An after-run correction also ensures that the dosing of the components is effected with a high degree of accuracy. The dosing procedure is ended shortly before the recipe quantity is reached, in order to compensate for overdosing resulting from the time it takes for the valve to close.

The sequence of the individual dosing procedures is controlled by the recipe. Some procedures can take place in parallel. Water is always the last component. The adding of the remaining quantity of water causes all residues of product to be flushed out of the tanks and pipes into the mixing tank selected. The mixing tanks are equipped with agitators or jet mixers, in order to achieve a homogeneous blend of products that have been dosed in one after another and to finally complete the dissolution of any pre-dissolved dry substances. The complexity of the system described here can be reduced if, for example, concentrate containers are dispensed with. But it is also possible to add additional dosing lines. The batch mixer is very flexible, and can be adapted easily to new products.

Continuous in-line blending system for finished beverages

In the case of in-line blending, liquid components are continuously blended in the pipe in constant proportions. This enables the precise blending of practically any desired number of components to be effected.

As a rule, the main component, water, will be introduced into the system via an external pump. In order to minimise product losses of expensive concentrates and base materials, containers and vessels are positioned as close to the system as possible. For preference, the ingredients are made to flow into the system by gravity. After deaeration they are conveyed



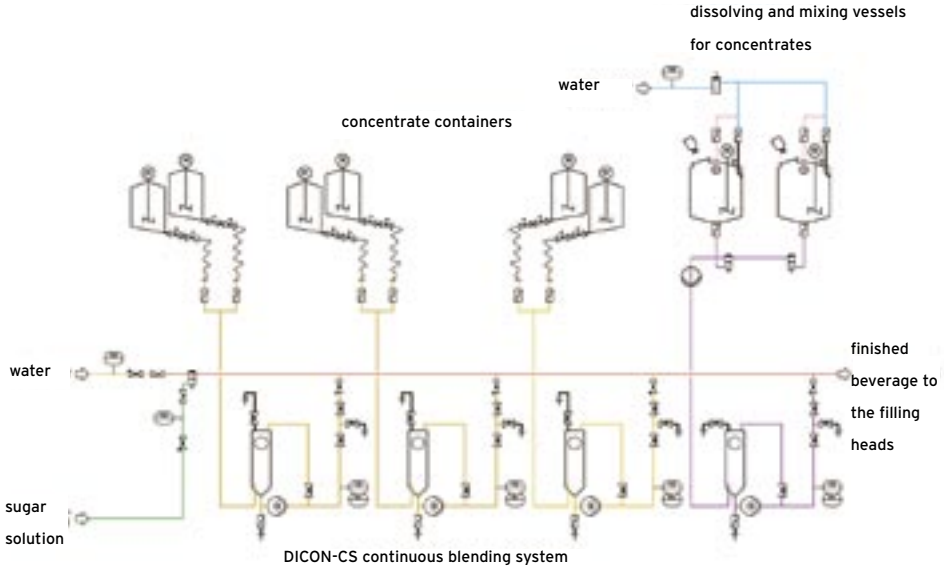
into the mixing pipe by centrifugal or displacement pumps integrated into the system.

If there are any components that involve the risk of air being trapped in them, deaeration vessels are required. They serve to separate out any air that may have been entrained, to switch over product introduction automatically (if a vessel or container is empty), to report lack of product and to regularly carry out an automatic check on the functioning of the flow meter in the concentrate area.

All quantities of the flows of liquid are constantly recorded by the flow meter and passed on to the plant control system. The regulator compares the metered values with the prescribed mixing proportions of the individual components, and controls the regulating devices in such a way as to precisely comply with the recipe values.

One important precondition for highly precise blending is the use of accurate and reliable flow meters. The tolerance of the flow meter is directly reflected in the result. Depending on the product and the recipe requirements, either volumetric or mass flow meters can be used.

Regulating valves or positive pumps with frequency converters are used as regulating devices. The regulating valves use a movable cone to restrict the volume flow. They are equipped with a pneumatic drive and a positioning regulator; the product is conveyed by centrifugal pumps. Positive pumps with frequency converters are used for viscous products and components with low flow speeds. With the aid of the regulator, a frequency converter can be used to adjust the speed of the pump in such a way as to achieve the flow speed desired.



DICON-CS continuous blending system

The high degree of complexity of the batch mixing system can be reduced if, for example, concentrate containers are dispensed with. But it is also possible to add additional dosing lines. The batch mixer is very flexible, and can be adapted easily to new products.

The introduction of small flow quantities into a large-volume flow makes particular demands on the dosing point. Here, only small diameter pipes may be used for the side inflows, in order to prevent the uncontrolled washing out of the concentrates from large diameter pipes. Special shut-off valves are positioned directly at the mixing pipe. For homogeneous blending a static blender is used, its deflection plates causing large amounts of turbulence in the liquid. Depending on the task in hand and the properties of the product, other technical solutions can also be employed.

To guarantee a high quality of product, a digital regulator is used. This regulator is specially designed for use with continuous blending equipment. It is equipped with inputs for quantity signals, making it possible for regulation to be effected precisely to the pulse, without additional errors arising from signal conversion. Any errors that do occur in the short term are compensated for completely by regulation. A positive deviation, e.g. one occasioned by a sudden rise in the pressure in a component, will be completely compensated for within a short time by a correction in the negative direction.

Photos and diagrams: GEA Diessel GmbH

If the stored recipe also includes individual quantities per component in relation to any desired total volume, this simplifies operations and the subsequent verification of the recipes. From this data, the control system automatically calculates the mixing proportions.

The recipes for the various products are stored in the control unit. In addition to the blending proportions, target values for analysis, limit values for monitoring and possibly also product parameters are stored. Entering individual quantities per component in relation to any desired total volume into the stored recipe simplifies operations and the subsequent verification of the recipes. From this data, the control system automatically calculates the mixing proportions.

The tasks of plant control systems

In addition to the dosing, regulating and control functions proper, the plant control system has further tasks:

- calculation of quantities or proportions from product-specific values
- automatic correction if the Brix value of the sugar solution fluctuates
- logging of the course of operations and of process data
- protection of target values and regulating parameters from unauthorized access
- control of the forward propulsion and expulsion of the product
- cleaning of the complete plant or of parts of it
- monitoring of when a product is used up, possibly automatic change of tank
- monitoring of raw materials by the measurement of their conductivity or density
- flow monitoring
- monitoring of regulating variances
- testing of individual flow meters using testing vessels
- checking that valves and pumps are functioning correctly
- monitoring of agitation times, in the case of products in which sedimentation tends to occur

Any errors that occur are reported and logged; production is interrupted and continues only if the operator gives his release.

Conclusion

The right conception for a new production plant must be determined through intensive dialogue between the plant operator and the plant builder. There are no standard solutions. The selection is dependent upon many factors:

- total output of the plant
- product variety
- batch sizes
- available space
- availability and type of raw materials
- degree of automation desired
- cost limits.

Further criteria are to be taken into account for different applications. Only a manufacturer with many years of experience in building mixing equipment can find the optimum solution for each individual case.

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The Author

Gerhard Bohne, born 1950; trained as an electrical technician; further training to become a state-examined electrical technician. Has worked at Diessel (now GEA Diessel) since 1977; group leader in the Design department and project manager. As from 2000, responsible for equipment planning and for preparing offers in the Sales department