# Automation for blending systems

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**For most people milk is only a white liquid served in a glass available with different fat contents, e.g. 3% and 0.5%. It is however not an easy task to obtain these fat-standardised products from cow milk. It becomes even harder if other ingredients like chocolate or strawberry are to be included.**

First of all, cow milk consists of water, fat and SNF. SNF stands for Solids Non Fat and consists of proteins, lactose and minerals. To get standardised milk, the cow milk first has to be separated. This is done in a separator (see Figure 1) which rotates with a high velocity. This make the heavier part of the milk go towards the edge while the lighter part will stay in the middle section due to centrifugal force. The heavier part is called skimmilk and consists of the same elements as the cow milk but with less fat. Cow milk has approximately 4% fat while skimmilk has 0.05% fat. The lighter part is defined as the cream and has 40% fat.

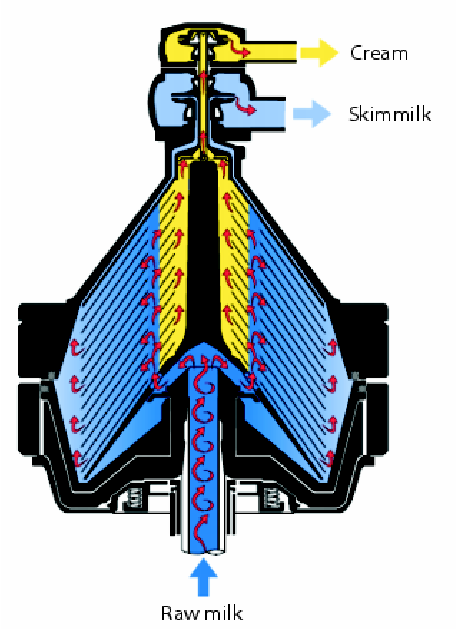


**Figure 1.** A cross-section of a separator.

To get 3% fat in the standardised milk some of the cream has to be mixed with the skimmilk, a so called cream remix. The surplus of cream can then be used for other, more fat needy, products like whipped cream, butter and cheese.

If other ingredients are also mixed in, e.g. chocolate or strawberry, these might also have some fat. Then this fat has to be compensated for by remixing less cream, thus getting the right fat content in the final product. The more ingredients, the harder it gets to create a product with a prescribed fat content.

All this mixing requires calculations of mass balances, i.e. how much of each component that has to be added to if a product of a certain result is desired. These calculations are then used with controllers and valves to change how much of each ingredient that should be mixed in. The calculations and communication are performed in a control system, where the central part is a so called programmable logic controller or PLC. A PLC is a special small computer with high demands on reliability. They also have inputs and outputs where signals are received from the sensors and sent to the actuators. Because of high accuracy demands in the mixing there also are high demands on the sensors and actuators. Between the PLC and the sensors there are I/O-modules (I/O – Input/Output) which also have very high accuracy demands.

Both performance and I/O-modules have to be considered when choosing an appropriate automation system. Other factors that are important are size of the manufacturer, price and how easy and well-structured the programming can be done.

Since PLCs often are very expensive and relatively slow, compared to a standard PC, an alternative to PLCs has been developed in recent years, i.e. SoftPLC. A SoftPLC is in fact a program run under

Windows (or other operative system) that is programmed with the same tools as a PLC. The difference is that the SoftPLC get the performance of a PC which widely surpasses that of a PLC. The price will also be lower. On the other hand, there is some question about the reliability since PCs have moving parts like fans and hard drives. Because of this, industrial PCs have been developed that do not require any moving parts. An illustration of the difference between a PLC and a SoftPLC can be seen in Figure 2.

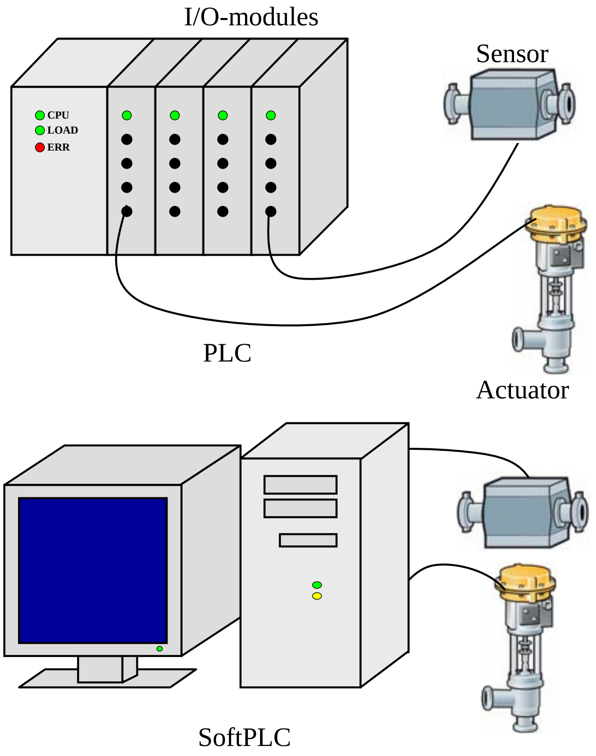


**Figure 2.** Difference between a PLC and a SoftPLC.

An analysis of how well PLC and SoftPLC systems could fulfil all of these demands has been done. In the end only three major manufacturers where left; Rockwell, Siemens and ABB. Out of these ABB was considered to have the best PLC while Siemens had the best SoftPLC.

Earlier, there have been a maximum of how many ingredients that could be mixed at the same time. This maximum is not caused by any physical limitation but from the structure of the software. When the first program was developed no one could think that more than 3-4 ingredients would be interesting. But today, there are demands of 7-8 ingredients.

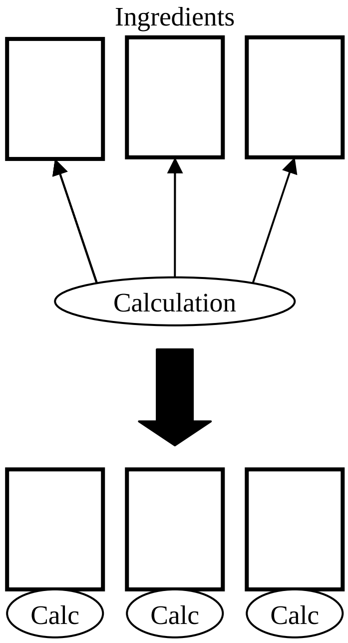


**Figure 3.** The centralised calculation has been changed to a decentralised where the calculations for an ingredient are made together with the ingredient.

To overcome this problem, a decentralised calculation has been developed which means that all calculations have been moved from a central location in the program to the parts that take care of each ingredient (see Figure 3). This eliminates most of the code writing that has to be done if another ingredient is wanted.

With more and more ingredients, the calculations have been more complex. If there is a disturbance on one of the ingredients this will affect all mixing calculations which will try to compensate for the error. This will make the system more unstable which is not a desirable property. This can be overcome by only allowing the ingredient where the error has occurred to compensate for the error. There will then be a small error in the outgoing product for the moment. This can however be compensated for over time by using a special compensating controller that minimises the total accumulated error.

**References:**

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