E&B RÄUCHERTECHNOLOGIEN AG

Cooking of Meat and Sausage Products

At first a most important question:

Why does meat and sausage products have to be cooked?

These products have to be boiled to avoid their premature perishing. To do so, small portions are processed in kettle e.g. hot water or larger quantities are processed in “Steam Chambers” with saturated steam.

This process of making meat and sausage products longer lasting has to be done in a way, which is not harming the quality of these products in any way. That is the most difficult part of this process.

Consider how often were meat and sausage products overcooked due to a too long or too hot cooking process, because of a broken thermometer or a missing or unreliable timer.

The same mistakes did happen in large “Steam Chambers” as well. The only difference was, that the affected quantity was much larger and therefore much more serious.

To avoid these costly mistakes the control systems had to be improved. These days the control systems are operating with more reliable timers and better temperature control devices.

In recent time the exact control and adjustment of the core temperature is becoming more and more important.

Tel. +41 71 6346050 | Fax +41 71 6346050 | E-Mail info@ebsmoke.com | www.ebsmoke.com

Due to monitoring the core temperature it is possible on one hand to control better the scalding process it self and so to avoid an unnecessary loss of weight.

Monitoring and control of the core temperature also increases the reliability of the production process and improves the quality of the finished product.

What is the relationship between the scalding process and the expiring time of a product?

It is known since a long time that the high temperature during a canning process will drastically reduce the number of microorganism, which are responsible for perishing the product.

The canning process also proves that not only a high temperature is important, the time period of the process at a certain temperature is important as well.

The relationship between a certain temperature and the time period of the process at this temperature is expressed as F-Factor.

The importance of this F-Factor and his influence in regard to an optimized canning process are known since a long time.

The principle and influence of the F-Factor in general is the same for a common cooking process, even when this process reaches only a temperature of less than 95 ° Celsius.

This pasteurizing process kills mainly the most resistant D-Streptococci. The optimal F-Factor for the pasteurizing process was successful discovered by scientific research and experimenting.

How to calculate the F-Value?

The calculations are based on the number of microorganism, which are terminated at a temperature of 55 ° Celsius. These microorganisms are especially D-streptococcus.

Therefor, whenever the temperature in its product is above 55 ° Celsius, the total number of bacteria cells will be reduced. The reached temperature per minute reflects also a certain F-Value.

The F-Value of the pasteurizing process is based on the following data:

Measured start temperature: 55 ° Celsius

Reference temperature: 70 ° Celsius

Z-value: 10 (value of time and temperature ratio)

Calculated with the known formulas based on these data, results in the following table, representing the F-Value at a certain temperature:

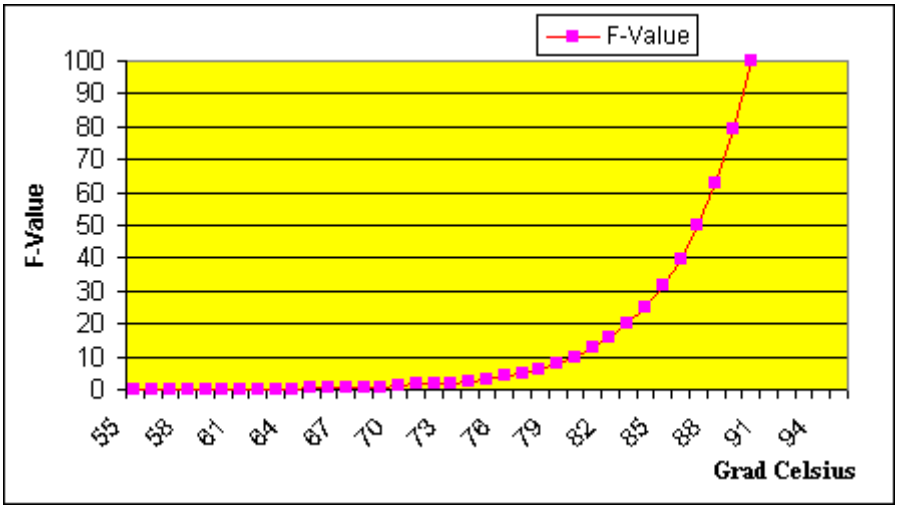
Grad-Celsius	F-Value	Grad-Celsius	F-Value
055	0.032	076	3.981
056	0.040	077	5.012
057	0.050	078	6.310
058	0.063	079	7.943
059	0.079	080	10.000
060	0.100	081	12.589
061	0.129	082	15.849
062	0.158	083	19.953
063	0.200	084	25.119
064	0.251	085	31.623

Tel. +41 71 6346050 | Fax +41 71 6346050 | E-Mail info@ebsmoke.com | www.ebsmoke.com

065	0.316	086	39.811
066	0.398	087	50.119
067	0.501	088	63.096
068	0.631	089	79.433
069	0.794	090	100.000
070	1.000	091	125.893
071	1.590	092	158.489
072	1.585	093	199.526
073	1.995	094	251.189
074	2.512	095	316.228
075	3.163		

The content of the table also shows that every temperature rise by 10 ° Celsius results in a rise of the F-Value by 10 times.

The relationship between temperature and time is obvious as well. For example, if in a product the temperature is 63 ° Celsius over 5 minutes, the F-Value would be 1.000. The same F-Value would require by 70 ° Celsius a time period of only one-minute.



What should the End-F-Value of a cooking process be?

It is recommended to reach an F-Value of 40, which is based on the following data:

Total number of bacteria cells	before cooking	10 E 7 total bacteria/gram
Total number of bacteria cells	after cooking	10 E 3 total bacteria/gram

In praxis, this reduction of bacteria cells represents that 99 of 100 products are bacteria free and the one product left has one bacteria cell.

How to calculate the End-F-Value?

There are two options to calculate the End-F-Value. One option requires the graphically record of the core temperature.

The recorded graph showing a temperature above 55 ° Celsius has to be divided in one-minute sections. This has to apply to the whole graph above 55-° Celsius.

Every time period shows now a certain temperature which reflects also the related F-Value.
The summary of all those F-Values equals the End-F-Value.
This option most likely takes place only if the observation of the whole cooling process is necessary.
The second option is a computerized observation. A temperature sensor is placed in the product itself to measure the core temperature. All measurements are electronically recorded. The F-Value will be electronically calculated and reported. This option opens also the possibility of a computerized process control system.

Why the F-Value and not the core temperature?

When we look at the complicated calculation of the F-Value, this question appears to be obviously. The control of the cooking process in regard to the core temperature seams much simpler.

However, the common determination of the End-Core-Temperature as known is simply wrong these days.

The varieties of products, there differences in sizes, weights, and most important the differences in the ability to conduct heat, leads always to different results even by the same core-temperature. Especially in regard to varnishing microorganism and so in regard to the life time of products.

However, a certain F-Value always represents the same result in regard to terminated microorganism. That means always the same established lifetime for a product.

These F-Value related results requiring on the other hand always a different core temperature. That means it would be necessary to determine always a different End-Core-Temperature. That is simply impossible.

Why we are starting to talk more about cook damage in the cooking process?

If the temperature of the room and core of the product would be graphically recorded separately, these graphs would show exactly, that the room temperature is faster rising then the core temperature.

The reason is the different ability of air and product to conduct heat. Therefore, it is obviously wrong to operate the cooking process only in regard to room temperature and not to consider the less rising core temperature of the product at all.

For example, it is probable wrong to run a room temperature of 75 ° Celsius from the beginning when the Start-Core-Temperature of the product is only 12 ° Celsius. Since the Start-Core-Temperature is rising slowly only, a much lower room temperature would be appropriate at the beginning of the process. Until now, this problem is only an energetic concern.

A high room temperature at the beginning of the process on the other hand has a negative influence of the product quality. These negative influences like the build up of jelly, the reducing of vitamins etc, are expressed by a comparison Value called " -Value".

The C-Value is determined by a calculation based on the room temperature graph. This calculation is similar to the F-Value calculation. However, the results of the C-Value are different. The calculations are based on the following constants:

Measured Start Temperature:	55 ° Celsius
Reference Temperature:	100 ° Celsius
Z-Value:	38 (Value to express the time-temperature ratio of the process of cooking)

Grad-Celsius	C-Value	Grad-Celsius	C-Value
055	0.065	081	0.316
056	0.070	082	0.335
057	0.074	083	0.357
058	0.078	084	0.379
059	0.083	085	0.403
060	0.089	086	0.428
061	0.094	087	0.455
062	0.100	088	0.483
063	0.106	089	0.513
064	0.113	090	0.546
065	0.120	091	0.580
066	0.127	092	0.616
067	0.135	093	0.654
068	0.144	094	0.695
069	0.153	095	0.739
070	0.162	096	0.785
071	0.173	097	0.834
072	0.183	098	0.886
073	0.195	099	0.941
074	0.207	100	1.000
075	0.220		
076	0.234		
077	0.248		
078	0.264		
079	0.280		
080	0.298		

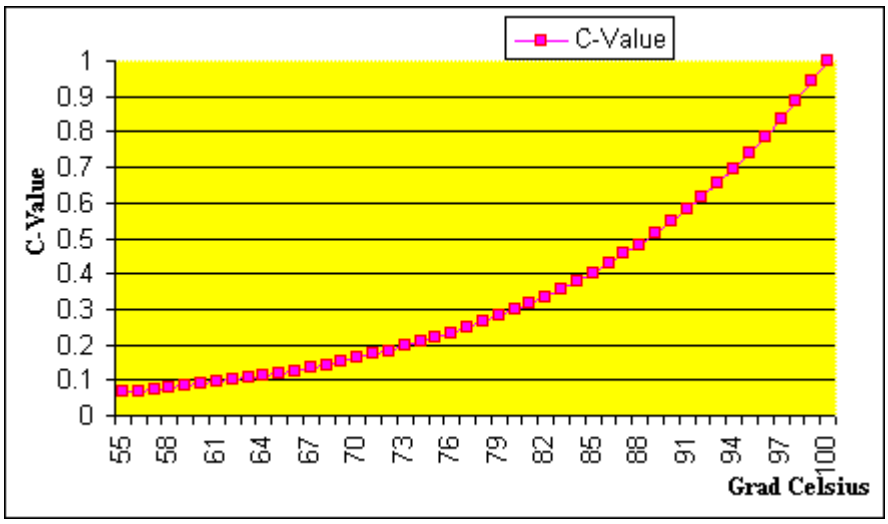
As the table shows. the C-Value is multiplying by 10 only every 38 ° Celsius of the rising temperature.

In regard to product-damage during the cooking process. it means unnecessary high temperatures are of negative affect to the whole process.

If for example. a product has to reach in a time period of 10 hours a temperature of 65 ° Celsius. To run the process either with 78 ° Celsius or 70 ° Celsius room temperature. will result into different " -Value's" as followed:

10 hrs with 70 ° Celsius = 600 x 0.162 = C 97.2

10 hrs with 78 ° Celsius = 600 x 0.642 = C 158.4



What End-C-Value is recommended?

The answer to this question is not so simple than by the "F-Value". Mainly it is important to reach the smallest End-C-Value during the process.

To reach an optimal cooking process. it is recommended:

Stabilize an ideal End-F-Value during the process. control and adjust the room temperature always to a necessary minimum during the whole process and try to avoid damage to the product during the cooking process due to establishing a low C-Value

How to optimize the cooking processes according to these criteria?

The first step is that the cooking process is closely watched with a register device or with a special computer control.

When you have a register device. you are able to get the temperature curve for the core temperature and the room temperature. You will get the conclusion for the current value of the F and C Value.

You get to watch out that the so to call "step cooking program " gets good results with the C Value.

The total optimizing is only possible via a computer control. that is able to continuously calculate the F and C Value to adapt the room temperature to the Process. to achieve a low C-Value with a minimum of energy and the cooking process can be controlled by the F- Value. To do this. the control must be able to carry the cooking process as Delta-cooking out. so the Delta-T- Values variable can be selected.

What is a Delta-T- cook program?

Delta stands for difference and T for temperature. This means that there is a temperature difference in the cook program. But what temperature difference? The difference between the core and the handling temperature. The factor of the different is unclear. the reasons are the criteria: product size. caliber. heat guide worth.

Some favor a Delta T from 15 ° Celsius. others favor 20 e.g. 25 ° Celsius. This why the Delta- cook program is only then sufficient. when you adjust the variables from program to program.

Here is an example: A charge ham is to be cooked at a core temperature from 68 ° Celsius. You have a cook program with a Delta T from 25 ° Celsius. Now you choose 75 ° Celsius for the handling temperature. The beginning core temperature is 12 ° Celsius.

After you start the program the handling temperature in the System should be constant 25 ° Celsius above the core temperature. You need a room temperature from 37 ° Celsius to begin with. The Delta T = 25 ° Celsius is from the time. that the core temperature is plus 25 ° Celsius more than 75 ° Celsius just no more kept. From this moment on the maximum handling temperature is 75 ° Celsius.

Depending on the product. size. caliber. heat guide worth. the cooking process has a different length.

The time span is with this simple program not definable. Off course is the achievable F Value not known. because the core temperature is uncontrolled.

A noticeable improvement brings this way Delta- Cooking with respect to cook damage and vigor expenditure matched with normal cooking or step cooking programs.

The Delta cook program must be build very differently. to process as precise as possible the core temperature curve control

Such programs demand three criteria's. where the system is able to corrected and intervene the process at any time.

To this is per a at catch- moreover. the process duration defaulted and a destination worth for the processing and nuclear temperature required and to this is a beginning of. and target value for those processing and core temperature is required and the process duration is pre-set.

By means of these data become calculated by the computer the program process on account of the initial values is the Delta T for that program determines respective. so it is the same size. for the user who needs it. The target values serve running in parallel to calculation of the linear temperature process for the reference value of the core temperature and the room temperature. which serves as maximal limitation.

During the process of this program attempts the control. the cooking process as to the actual value of the core temperature on the calculated reference value run. That means that the heating is inserted always only then. if this becomes necessary on account of a too deep core temperature.

Since the core temperature increase occurs slowly. the heating capacity is inserted clocked in the Delta cook phase. as necessary around really only currently as is needed. Since this program calculates and also controls a straight line of the start for the process of the core temperature for the target value. already can while generating one expect for-evaluate may be calculated. This brings a very great reliability of the production process and constants in quality for the user.

What is the gained experience with the F-Value controlled programs with in the end mentioned Program State.

Following results could be summarised.

On account of extended time tests in a model according to the newest findings. between 800-900 kilograms Cooked ham where produced every night over a period of 9 months.

The numbers achieved in this case stand compared to hams produced up to now with step cooking programs.

Experimental report:

HT	=	House	Temperature
CT	=	Core	Temperature

600 = 600 min (sample applies to 10 hours)

Used system type: 2 car-system low pressure- vapor- directheating
Startingcoretemperature: 12-14 ° Celsius

Applied program:	1. Cooking	60 ° Celsius HT to 45 ° Celsius CT
Up to now	2. Cooking	65 ° Celsius HT to 60 CT
	3. Cooking	73 ° Celsius HT to 70 ° Celsius CT
	4. Shower	30 minutes without Interval

Optemiertes program:	1. Cooking	54 ° Celsius HT- 15 ° Celsius CT
	2. Delta	75 ° Celsius HT- 69 ° Celsius CT
	3. Cooking	70 ° Celsius HT - 40 F- Value
	4. Shower	30 minutes without Interval
		Heating takt rate 30% from 100

Comparison of the results

Criteria	up to now	optimized	difference
F- Value	>100	55.50	- 45.50
C-Value	92	54.58	- 7.42
Loss of weight	12.50%	9.50	-3.00%
Heating use	100.00%	72.70%	-27.30%
Charge time	11.50h	11.50h	+-0
Injection amount	15.00%	13.00%	-2.00%

On account of the desired reliability of the comparative figures. the program has not been optimised during the test series. Nevertheless. results are very impressive. Only the two most important might be highlighted.

1. Energy savings of 27% compared to a step-cooking program improved to some extent.

2. Weight loss reduction of around 3%. although the injection amount within the experiments was already reduced by around 2%

These results show more easily the unavoidable course over the F- Value -cooking and the results can be improved with process optimising.

Which products should bee cooked with the F- Value?

The F- Value cooking concerns all products with which it is possible to carry out a core temperature measurement.

The opinion is. that it is not necessary to cook Wieners after the F- Value.

Therefore should require only the products. with long cooking times and a long durability strength according to method be cooked.

The application of the F- Value cooking has an absolute authorization in case of a small-bore product. when it is about pasteurized product.

The application of the Delta-cooking stands with the total cooking time of a product certainly in connection.

Therefore, products with large dimension are only treated after this system.

At the end we can say that the very simple cooking process has a great variation and interesting aspects hiding in itself.

An over-thinking of the own Product-palette always benefits, since practical in every operation optimization possibilities exist and the necessity to improve the less and less margins.