



"HENRI COANDA"  
AIR FORCE ACADEMY  
ROMANIA



GERMANY



"GENERAL M.R. STEFANIK"  
ARMED FORCES ACADEMY  
SLOVAK REPUBLIC

INTERNATIONAL CONFERENCE of SCIENTIFIC PAPER  
AFASES 2011  
Brasov, 26-28 May 2011

## PHYSICAL PARAMETERS INFLUENCE IN FRIED POTATOES PROCESSING

MATEI Mihaela\*, CSATLOS Carol\*\*

\*Food and Tourism Faculty, Transilvania University, Brasov, Romania, \*\* Food and Tourism Faculty,  
Transilvania University, Brasov, Romania

**Abstract:** Paper presents reducing of Acrylamide content forming by process steps optimization of fried potatoes. It is presented the impact of fried potatoes slices humidity, inlet and outlet process temperature in Acrylamide forming. There is also presented Acrylamide potential measured with different laboratory equipment.

**Keywords:** frying, temperature, moisture, Acrylamide.

### 1. INTRODUCTION

Acrylamide is a „potential human carcinogen” substance and therefore poses a serious HAZARD to human health. The magnitude of the real risk cannot be evaluated and a non effect level has not been established so far. In this respect the „ALARA Principle”(As Low As Reasonably Achievable) is applied by snacks producer in order to minimize the Acrylamide content as result of food processing. Potato Snacks and are at the top of the list of amounts of Acrylamide found per kg of final product. The issue is known since 2002. Mitigation in different European countries is not done with the same emphasis and priority.

Potatoes tubers are washed, pilled and cut in slices. Raw, washed and partially dried slices go through the deep fryer to be steadily deep-fried in hot edible oil. The process of deep frying is divided into three phases which vary depending upon the aid of the physical

processes on and in the product characteristic features resulting from it.

The first phase of the crisp building is called vaporization. This phase is characterized by the uninhibited vaporization of the freely contained water and unbound water in the cell membranes and cell walls. This phase is executed in the deep fryer, generally in the area of the turn wheels.

Under the dipping belt or pressure belt many product features are already created. Here the drying of the product takes place. Essentially the vaporization occurs to macromolecules (starch, proteins, pectin) of bounded water. The usual boiling temperature does not manage to convert this water directly into steam. The last phase is called cooling and is typical for the process on the discharging transporting belt. [4]

The driving factor for the vaporization is the oil temperature. The higher temperature, the more intensely and the shorter is the deep frying process.

The edible oil circulation system is an open system without pressure and exists on the deep fryer basin with entering and outlet canals, a fine material separation, a main pump, a temperature regulation system, a heat exchanger as well as one or more edible oil buffer tanks with the suitable pumps and conduit systems for the filling and refilling. In addition, a heat exchanger is necessary for the edible oil cooling, to cool the edible oil quickly after equipment shutdowns or while shutting down the equipment. [2]

A very important driving factor in Acrylamide reducing is represented by the frying temperature. A low frying temperature can reduce the impact of Acrylamide forming.

The stabilization of the product moisture occurs through the duration of the slices in the deep fryer. In the zone of the finished baking, that means the point in the deep fryer where the intense steam development has already decreased and the slices only release a little water, the greatest possible control is necessary in the product guidance. This is managed by the so called pressure belt (preferably the under diving belt, submerging belt) under which the slices are piled up at the outlet from the last paddle. [3]

The final humidity content in finished goods is also very important as a potential in Acrylamide forming. The humidity should be as high as acceptable from technological process point of view. [5]

## 2. MATERIALS AND METHOD

Moisture content of fried potatoes slices was measured with a thermo hygrometer. Is an instrument used for measuring the moisture content in the environmental air, or humidity. Humidity is difficult to measure accurately. Most measurement devices usually rely on measurements of some other quantity such as temperature, pressure, mass or a mechanical or electrical change in a substance as moisture is absorbed. From The classic laboratory method of measuring high level moisture in solid or semi-solid materials is loss on drying (LOD). In this technique a sample of material is

weighed, heated in an oven for an appropriate period, cooled in the dry atmosphere of desiccators, and then reweighed. If the volatile content of the solid is primarily water, the LOD technique gives a good measure of moisture content. Because the manual laboratory method is relatively slow, automated moisture analyzers have been developed that can reduce the time necessary for a test from a couple hours to just a few minutes. These analyzers incorporate an electronic balance with a sample tray and surrounding heating element. Under microprocessor control the sample can be heated rapidly and a result computed prior to the completion of the process, based on the moisture loss rate, known as drying curve. [1]

Inlet end outlet temperature of oil inside frying equipment was read on equipment electric panel. Temperature values are read thanks to two sensors which are installed at the entrance and at the exit of frying equipment.

## 3. RESULTS AND DISCUSSIONS

By definition, the entering temperature is between 180 °C and 185 °C. This temperature range may be left only to produce special crisps with a higher fat content. The temperature must be stabilized by using a regulator and may vary in the stable maximum of an area from +/- 0.5 % °C around the set nominal value of oil. (Table 1)

Deep fried is basically up to the moisture defined in the process specification, normally within 1-2%. If the moisture sinks less than 1%undesirable effects appear like excessive fatness, darker coloring, burnt taste and a high Acrylamide value.

Deep fryers are to be designed with a temperature difference of 15-20K. Therefore the outlet temperature is normally between 160 to 170 °C. In case of special requirement, like the reduction of undesirable conducted substances which can originate during the deep-frying, the outlet temperature can lowered to 150 °C. Deep-frying less than 150 °C outlet temperature is to be avoided.



"HENRI COANDA"  
AIR FORCE ACADEMY  
ROMANIA



GERMANY



"GENERAL M.R. STEFANIK"  
ARMED FORCES ACADEMY  
SLOVAK REPUBLIC

INTERNATIONAL CONFERENCE of SCIENTIFIC PAPER  
AFASES 2011

Brasov, 26-28 May 2011

Figure 1 – Moisture content in fried potatoes

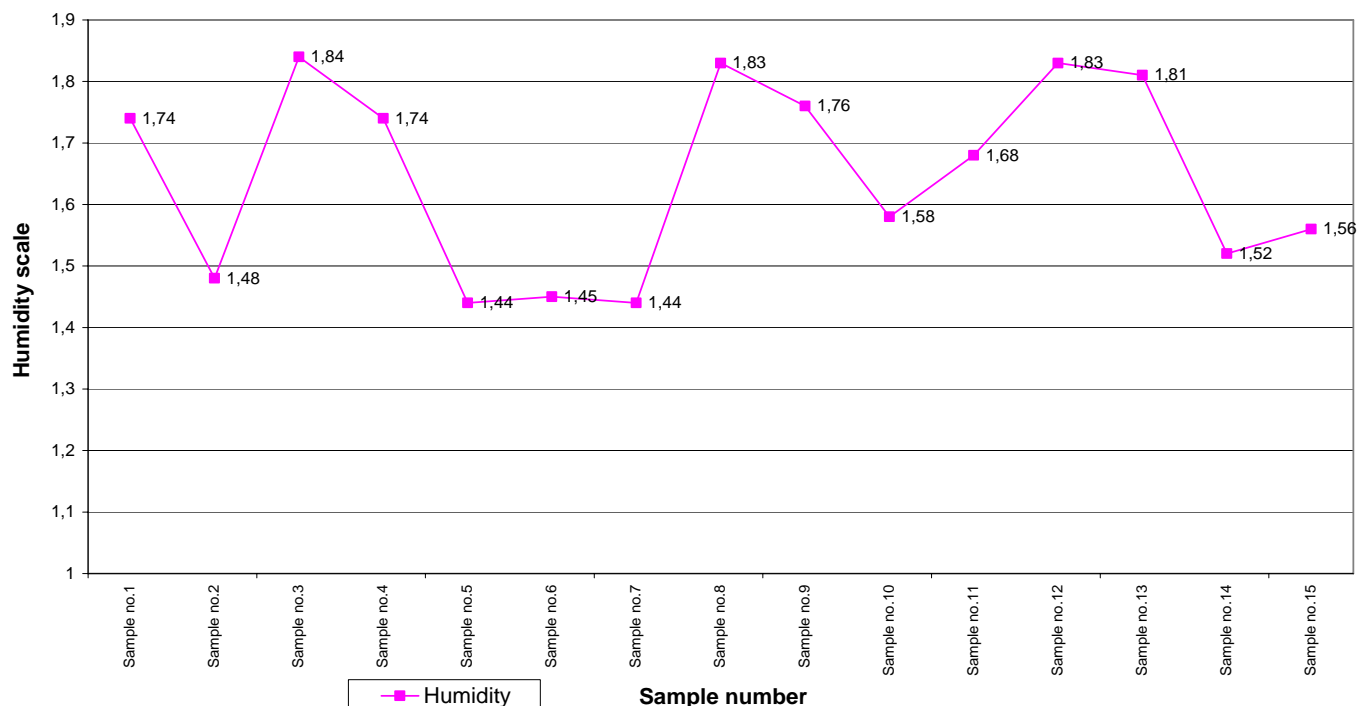
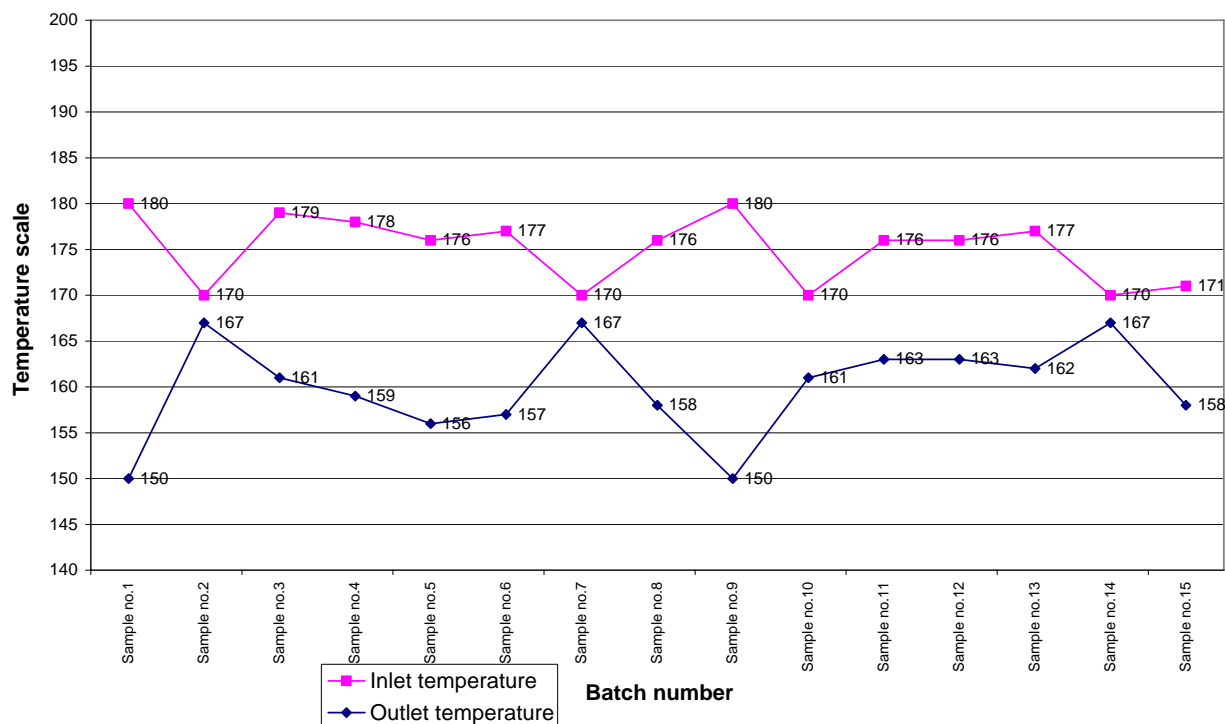


Table 1

Crt.no.	Date	Frying temperature in, °C	Frying temperature out, °C	Moisture, %	Sample number
1	03.01.2011	180	150	1,74	Sample no.1
2	03.01.2011	170	167	1,48	Sample no.2
3	11.01.2011	179	161	1,84	Sample no.3
4	11.01.2011	178	159	1,74	Sample no.4
5	17.01.2011	176	156	1,44	Sample no.5
6	17.01.2011	177	157	1,45	Sample no.6
7	25.01.2011	170	167	1,44	Sample no.7
8	02.02.2011	176	158	1,83	Sample no.8
9	02.02.2011	180	150	1,76	Sample no.9
10	10.02.2011	170	161	1,58	Sample no.10
11	10.02.2011	176	163	1,68	Sample no.11
12	14.02.2011	176	163	1,83	Sample no.12
13	14.02.2011	177	162	1,81	Sample no.13
14	22.02.2011	170	167	1,52	Sample no.14
15	22.02.2011	171	158	1,56	Sample no.15

Figure 2 – Inlet and outlet oil temperatures inside fryer



Oil temperature must be continuously documented to guarantee a well organized production procedure. Also moisture percentage is to be constantly monitored. This is the best achieved by the use of on-line controls which allow an immediate reaction in the process. In order to control the moisture percentage, an on-line measuring sensor in the discharger of the deep fryer must be installed at the point after which the crisps have already left the oil bath for 25-30 seconds. (Fig. 1) Ideally, for any given defined oil temperature, the dwell-time should be the same for the crisp with the same slice thickness.

To reduce the number of variables in production line the once temperature is set, based on the kind of potato and lot, the differences from one deep fryer to another deep fryer should be kept or be changed as little as possible. (Fig. 2)

### 3. CONCLUSIONS & ACKNOWLEDGMENT

Basically, zoned deep-fryers with at least three oil entering and three oil outlets are very important to obtain a good product from quality point of view. Furthermore the zoned

deep-fryer guarantees a higher flexibility with the setting of the temperature profile. Finished goods has a natural-yellow color, so a natural aspect, and has also characteristic crispiness of fried potatoes slices. Moisture variations must be controlled / monitored in order to avoid dark potatoes slices, because dark potatoes slices mean high Acrylamide content. The frying time per slice must be uniform with a right temperature profile for reducing Acrylamide.

### REFERENCES

1. Grob, K., Biedermann, M. *French fries with less than 100 µg/kg acrylamide. A collaboration between cooks and analysts.* European Food Research and Technology, (2003).
2. Gertz, C. *Optimising the frying and baking process using oil improving agents.* 4th International Symposium Deep-Frying, Hagen, (2004).
3. Fiselier, K., Bazzocco, D., Gama-Baumgartner, F., Grob, K. *Influence of the frying temperature on Acrylamide formation in French fries.* European Food Research and Technology, (2006).