Cracker Checking and Breakage

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Biography of Mihaelos N. Mihalos

Mihaelos (Michael) Mihalos is a chemical engineer and has over 29 years of engineering and research & development project management and technical experience with emphasis on the implementation of highly complex, innovative technology projects in the production environment and commercialization of new products/platforms and fluid mechanics/forming and heat transfer/baking. Currently as a Senior Associate Principal Engineer for Kraft Foods Inc., he manages complex technology development projects for Kraft Foods/Nabisco Biscuit & Snacks Growth Product Development Group. Over his career at Kraft Foods/Nabisco he has held various positions as an engineer in Process R&D, Biscuit Engineering, Technical Services, Manufacturing Development, Fair Lawn Pilot Plant, Process Technology, Growth Engineering and Biscuit & Snacks Growth Product Development Groups. Mr. Mihalos has an M.S. in Chemical Engineering from Columbia University, N.Y. and holds numerous US and international patents for innovative manufacturing processes and product designs for cookies, crackers and snacks. He recently edited the processing sections for the 4th edition of the Sosland Publication Textbook entitled Baking Science & Technology authored by Pyler & Gorton - Volume II.

Biscuit Checking & Breakage

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Abstract:
Biscuit Checking and Breakage

Biscuit checking is defined as hair line cracks which can appear within the product and on the surface from 12-48 hours after packaging and cause excessive breakage during distribution. This presentation provides an overview to the causes and possible remedies from mixing to post conditioning which effect cracker checking. Checking is not related to mechanical breakage. A case study is discussed in detail.

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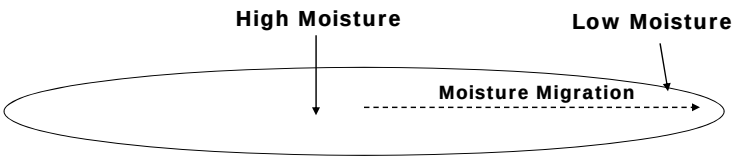
Background: Checking

- Hair line fracture formation in a biscuit
- Checking may start immediately after baking with small fractures that may not be visible, growing gradually to become visible over time
- Checking not related mechanical breakage
- A checked biscuit may not be visible to the plant and is almost certain to be broken before reaching the consumer

Checking is caused by uneven distribution of moisture within a product structure

- High moisture content
- Rapid cooling
- Insufficient dockering
- Baking time, temperature, oven humidity
- Contact on oven band
- Band Loading
- Formulation

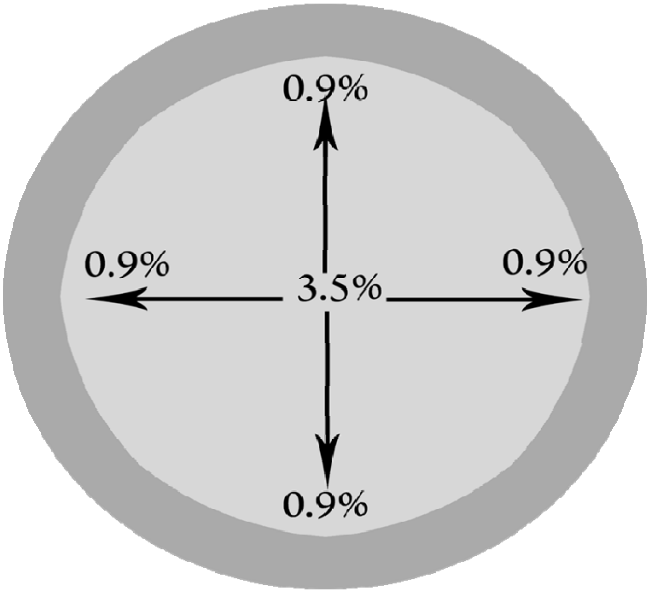
Checking Mechanism

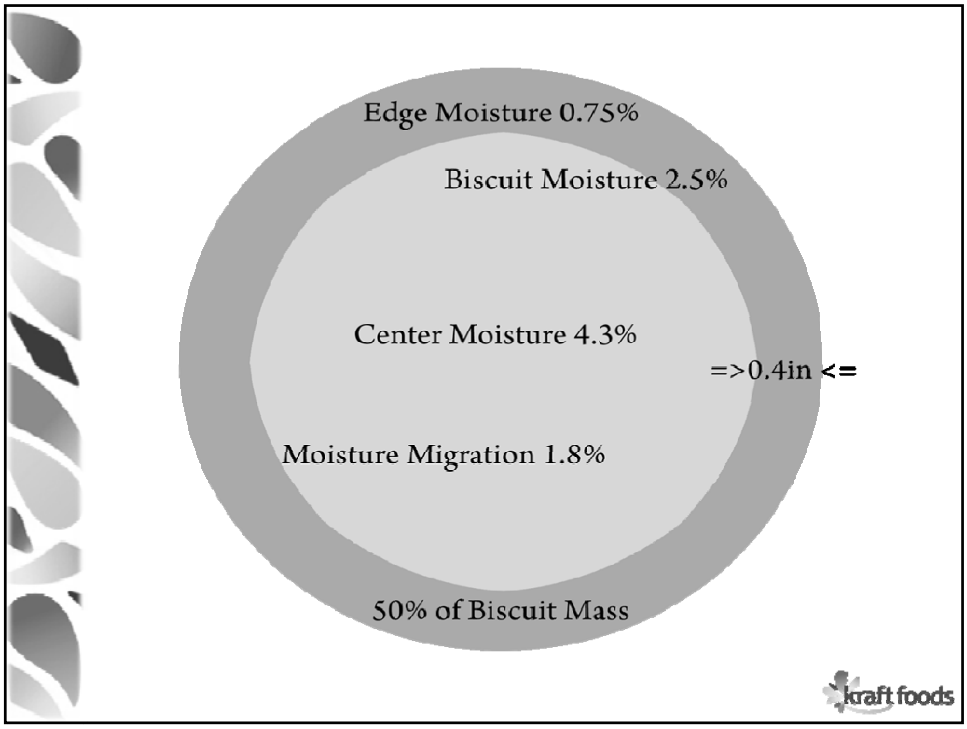


After Cooling

Moisture equilibration:
- Internal shrink
- external expand

CHECKING




Edge Moisture 0.75%
Biscuit Moisture 2.5%
Center Moisture 4.3%
=>0.4in <=
Moisture Migration 1.8%
50% of Biscuit Mass
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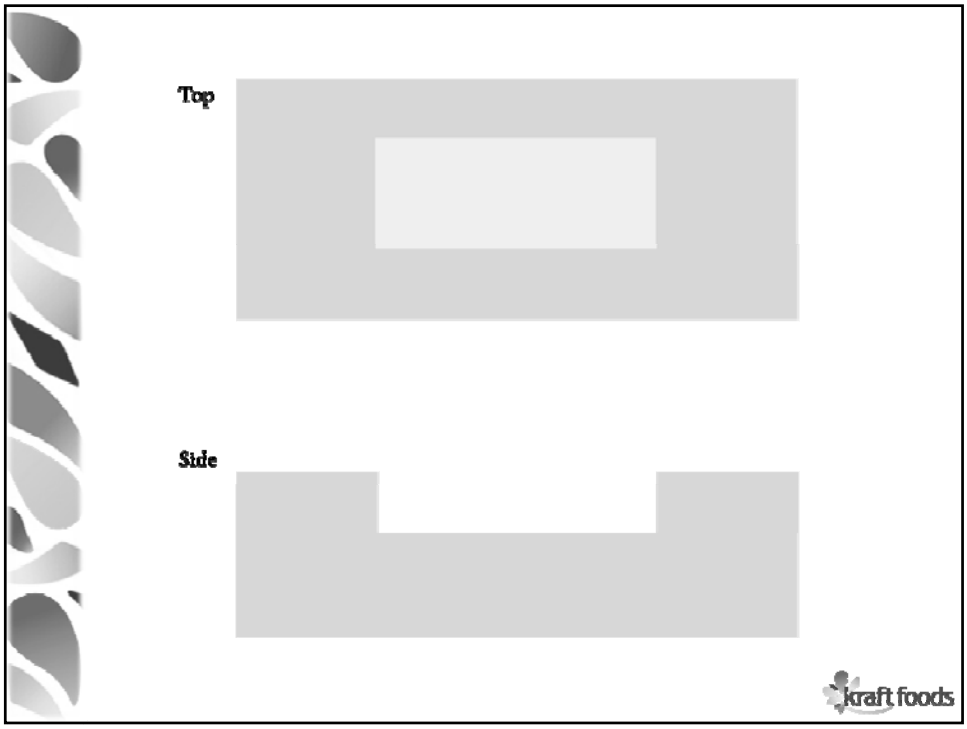
Top
Side
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Checking Mechanism:

Micro-fracture
(not visible)

Grow gradually

May take 3 weeks or longer

Visible Checking

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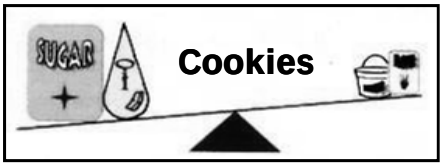
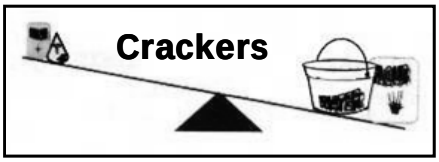
Products are categorized by the balance of flour, sugar, fat & water



- High levels of sugar & fat, low levels of flour & water



- High levels of water & flour, low levels of sugar & fat

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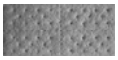
Typical Biscuit Formulations

				
	Very High	Very Low	Strong	Low
	High			
		Slightly Higher		

Cracker Case Study

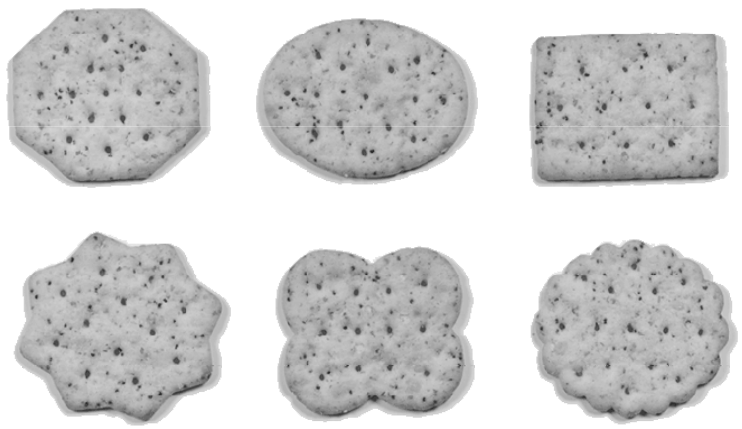
Objective:

- To reduce consumer complaints by developing a robust formula and process that minimize overall breakage

Causes of cracker checking / breakage

- Non-uniform piece weight
- Non-uniform moisture gradient
- High levels of particulates
- Insufficient level of dockering

Cracker Shapes



Cracker Shapes and Uniformity

Six shapes	Dough wt (g)	Dry wt. (g)	Moisture %
Star	25.2 (-2.7)	18.3 (-2.0)	2.20 (-2.8)
Rectangle	26.3 (-1.6)	19.0 (-1.3)	2.45 (-0.03)
Clove	27.5 (-0.4)	19.9 (-0.4)	2.11 (-0.37)
Octagon	28.3 (+0.4)	20.6 (+0.3)	2.43 (-0.05)
Scallop	29.6 (+1.7)	21.7 (+1.4)	2.94 (+0.46)
Oval	30.4 (+2.5)	22.2 (+1.9)	2.74 (+0.26)
Average	**27.9**	**20.3**	**2.48**

Cracker Solutions

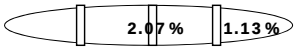
- **Redesign the cutter so that all shapes have identical piece weights and more docker holes**
- **Minimized the moisture gradient by:**
  - Oven profile and humidity
  - Longer bake time
  - Lower target moisture
- **Reduced level of particulates**

Results

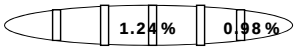
Adding dockers assists removing moisture from the interior of a biscuit during baking

Moisture gradient:

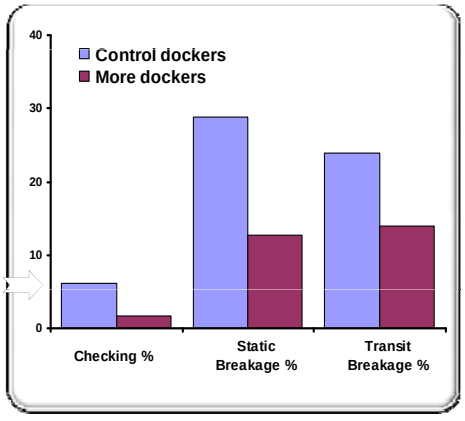
Control docker system



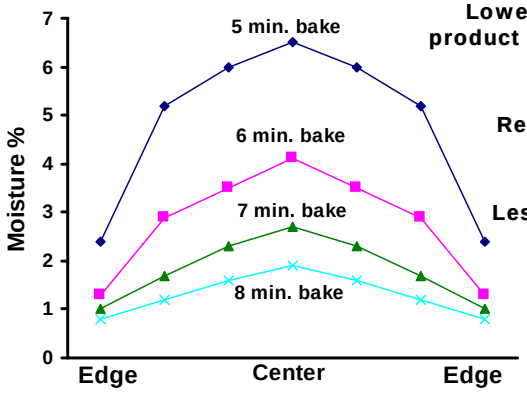
Revised dockers



- **Samples with more dockers have lower overall moisture and reduced moisture gradient from center to edge**



Effect of Bake Time on product moisture



Lowering moisture in finished product requires longer baking time

↓

Reduce moisture gradient

↓

Less expansion / contraction

↓

Less checking

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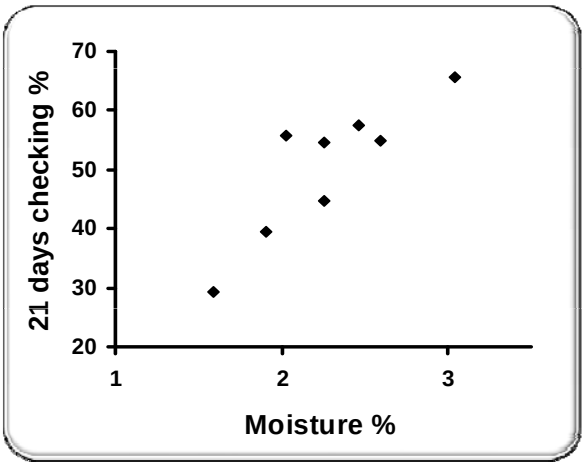
21-day Checking Procedure

Majority of checking appears within the 24-48 hour time period



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Checking: Major Causes / Approaches to Resolve / Prevent Checking

Mixing:

- **Maintain consistent dough temperatures in mixing**
- **Maintain consistent mixing time from batch to batch**
- **Evaluate formulation: fat level, emulsifiers, dough improves, aeration and invert sugar**
- **More thorough blending of ingredients to counteract checking**
- **Use lecithin / emulsifiers**

Forming:

- **Minimize dough weight difference across the conveyor belt**
- **Minimize sheet reduction using multiple gauge rolls**
- **Uniform distribution with fresh dough**
- **Use more dockers**
- **Product design and shape**
- **Keep dough weights similar for various geometric shapes**
- **Keep scrap return to the dough feed rolls hopper as warm as possible**

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Checking: Major Causes / Approaches to Resolve / Prevent Checking

Baking:

- **Keep oven humidity as high as possible in the first half of the oven** (i.e., reduce exhausting rates)
- **Oven band type: mesh versus solid**
- **Slower bake times – use more of the oven**
- **Maximize band loading** (minimize spacing between cracker pieces). **This helps reduce individual cracker moisture variation from center of the cracker to the edges / sides**
- **Use more open mesh baking bands**
- **When feasible, maintain top & bottom temperatures / heat levels as equal as possible**
- **Use dielectric dryers when possible**

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Checking: Major Causes / Approaches to Resolve / Prevent Checking

Post Baking:

- Cool the product as slowly as possible. Use covered tunnels rather than open air conveyors
- Cool the product when possible in a humid environment
- Avoid sudden, very cool drafts
- Heated conveying systems
- Post bake shingling at 45 degree angle
- Product bed height
- Di-electric heating

Radio Frequency (RF) Dryer For Post-Bake Conditioning

- Located either after, or in the oven itself
- The product is baked to a higher moisture level in the oven
- Makes the water in the product vibrate & heat up which releases the moisture
- Higher moisture levels will attract more dielectric energy. Therefore it is a ''self regulating'' moisture control