An Overview of the Milling Industry in China

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Education Background

**B.S.** Grain Science (Milling option), 2004  
**M.S.** Grain Science (research area: Wheat milling, cereal chemistry), 2008  
Henan University of Technology, China

**PhD.** Biological and Agricultural Engineering (research area: protein chemistry and bio-processing), 2013  
Kansas State University
Professional experience

- Design flour mills
- Zhixin was founded by the professors in Department of Grain Science at Henan University of Technology in 2001.
- Zhixin designed more than 600 flour mills in China and other countries.

Zhixin Grain Engineering Technology CO., LTD
Outline

- Overview of the milling industry in China
- Development of China milling Technology
China Crop Production Data

- Population: 1.4 billion
- Largest grain producer (500 MT annually) (US: 360 MT, India: 220 MT)
- Annual grain production:
  - Rice: 150 MT
  - Corn: 120 MT
  - Wheat: 100 MT (US: 55-60 MT)
  - Soybean: 15 MT
- Annual import:
  - Wheat: 9.6 MT (US, Canada)
  - Soybean: 80 MT (US, Brazil, AR)
  - Corn: 7.2 MT (US, Ukraine)
  - Rice: 5.3 MT
China Flour Mills Data

- More than 4,000 flour mills
- Large/middle size mills are the minority

Pie chart showing:
- >400 ton: 200 mills, 6%
- 200-400 ton: 415 mills, 13%
- 100-200 ton: 606 mills, 19%
- <100 ton: 1,966 mills, 62%

Total: 3,217 mills, in year 2013
Largest flour mill in world is in China (Wudeli Flour Group)

- **Wudeli Flour Group:**
  - Capacity: 62,000 tons/day (1.1 million cwts/day)
  - Market share: 21%.
  - 36 mills (83 line)
  - Employees: >5,000

- **Ardent Mill:**
  - Capacity: 26,000 tons/day (475,800 cwts)
  - Market share: 31%.
  - 40 mills
  - Employees: 2,400
Wudeli Flour Group

Capacity is projected to 62,000 tons/day by 2017 (1.1 million cwts).

Zhixin designed more than 15,000 ton/day for Wudeli
Mill size vs profit model

- **Class I**: large mill + large storage capacity (>12 month)
  - Profit: wheat trade and processing
- **Class II**: large mill + intermediate storage capacity (3-12 month)
  - Profit: wheat processing and trade
- **Class III**: middle mill (300-500 t/d) + small storage capacity (1 month)
  - Profit: wheat processing only
- **Class IV**: small mill (<300 t/d) + small storage capacity (10 days)
  - Profit: wheat processing only
China Milling Industry Data

- Profit is low: 1% (2015-2016), mainly caused by the “cliff-like drop” of price of wheat bran (from 15 cents/lb to 8.7 cents/lb).
Example: Cost structure of China Flour Mills. (operating time is 80%)
Serious overcapacity (milling capacity: 250 million tons per year, which is 2.5 times of the wheat production)
Small mills are closed because they are less competitive.
Big mills are getting larger and larger.

<table>
<thead>
<tr>
<th>Country</th>
<th>Peak</th>
<th>Operating time</th>
<th>Stable</th>
<th>Operating time (target)</th>
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<tbody>
<tr>
<td>US</td>
<td>?</td>
<td>n/a</td>
<td>190</td>
<td></td>
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<tr>
<td>France</td>
<td>1,400</td>
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<td>China</td>
<td>&gt;4,000</td>
<td>&lt;50%</td>
<td>?</td>
<td></td>
</tr>
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</table>
Wheat flour based food in China

- Noodle: 35%
- Steamed bread: 30%
- Cookies: 10%
- Other: 4%
- Bread: 3%
- Cake: 10%
- Dumpling wrapper: 8%

US

- Cookies: 18.75%
- Cake: 20.83%
- Whole wheat flour: 52.08%
- Semolina: 5.21%
- Whole wheat flour: 3.13%

China

- Noodle: 35%
- Steamed bread: 30%
Wheat flour based food in China

- **Streamed bread**: 30%
- **Noodles**: 35%
- **Stuffed bun**: 8%
- **Twisted cruller**:
- **Bread**: 3-5%
- **Dumpling**: 8%
China Milling Technology

Milling technology innovation:
- Optimum low-ash flour extraction rate
- Optimum total flour extraction rate
- Optimum the quality of finished products
- Optimum the capacity of the mill
- Flour safety
- Maintain flour quality consistence
- Manufacturing cost (Power consumption)
- Automation
- Others
China Milling Technology – history

- 1950-1980: short flow diagram (straight flour, ash is high)
- 1980-2000: medium flow diagram (purifiers, flour graded by ash)
- 2000-2008: medium flow diagram (ash content and electricity cost)
- 2009-present: long and wide flow diagram (low-ash flour, particle size, flour quality)
Break and reduction systems

1-3B, or 4B, 1-3 M:
- 1B produces up to 25-50% of flour; 1B break release: 50-70%; 1M produce 25% flour

Extraction: 83.6%, Ash: 0.97%,

Particle size: 210 µm

Corrugated rolls

Electricity: 40 kw/ton

Period I: 1950-1980
Period II: 1980-2000

- Medium length flow diagram (Buhler, Ocrim, Satake)
- B: Corrugated roll; M: Smooth roll
- 1-4 B, 1-7 M, 2S, 2T, 4-5 P
- Roll length: 12 mm/100 kg/24 h
- Sifting area: 0.08 m²/100 kg/24 h
- 1B break release: 30-40%, flour extraction of 1B: 4%
- Total extraction rate: 74-75% (F1: 53%, 0.53% ash; F2: 19.8%, 0.66% ash)
- Particle size: 12-13 XX (108 µm)
- Electricity: 75 kw/ton (17.8 cwt)
Period III: 2000-2008
-- how to reduce energy consumption

- Medium flow diagram (Zhixin, Golden Grain, Buhler)
- 1-4 B, 1-8 M, 2S, 2T, 4-5 P
- Roll length: 10-12 mm/100 kg/24 h
- Sifting area: 0.08-0.09 m²/100 kg/24 h
- 1B break release: 30-36%, flour extraction: 3-4%
- Total extraction rate: 75-76% (F1: 30-35%, 0.43% ash; F2: 35-40%, 0.58% ash; F3: 6%, 1.2 ash)
- Particle size: 12-14 XX (100 µm)
- Electricity: 60 kw/ton (60 kw/17.8 cwt)
Period III: 2000-2008

Impactor

Impactor (DM): D1, D2, 1S, 1M, 2M

Particle size: 108-181 μm

If capacity: 600 T

- DM: 600 x 12% = 72 T/D
- 2M capacity: 20 T/D
- 2M motor: = 15 kw/h x 4
- Impactor motor: = 15x1 kw/h
Period III: 2000-2008

Advantage:
- Energy consumption is low (60 kw/ton)

Disadvantage:
- Particle size is too small (100 µm)
- Ash content is high

Li et al. 2009 (MS thesis)
Small particle size results in high damaged starch

- Flour with particle size 11xx (123 µm) and DS 20.8 UCD (hard wheat) makes the best bread.
- Low DS results in coarse and non-uniform crumb texture.
- High DS lead to low volume and sticky crumb structure.

Li et al. 2009 (MS thesis)
Noodle and cake need low-ash flour

Effect of ash on noodle quality

- High-ash flour noodle is darker than low-ash flour.
- High-ash flour has higher polyphenol oxidase (PPO) content.
Period IV: 2009-present

---Significant improvement
(Zhixin, Golden Grain, Buhler)

Objectives:

- Increase low-ash flour yield
- Increase total flour yield
- Particle size
Period IV: How to increase low-ash flour yield?

- Minimum the flour yield from the break system (B).
- Maximum the high quality middlings from break system to the purification system.
- Must improve the break release quality.

Li et al. 2009 (MS thesis)
Period IV: Re-purification

Wudeli Flour Group:
750 x 4 ton/day
(13,500 x 4 cwts/day)
**Period IV: Roller length**

**Mill A**
Medium flow sheet (wedge)

**Mill B**
Long flow sheet (football)

Mill A: medium flow sheet.
Mill B: long flow sheet.
Summary of Period IV: 2009-present

- Longer and wider flow sheet (5B, 8M, 2S, 2T, 45-17P)
- Roll length: 14-16 mm/100kg/24h
- Sifting area: 0.1-0.12 m²/100kg/24h
- Break release quantity vs quality
- Purification: 3.5 mm (up to 17 P; middlings :150-950 µm); Re-purification
- Roll parameters
- Total flour yield: 78-80%. F1: 55% with ash content of 0.4-0.45%
- Energy consumption: 74 kw/t
Future trend

- Merge: mills number will decrease.
- Flour safety: Vomitoxin (mycotoxin, DON) fast detection and removing technology.
- Automation (clean, blending, milling, post-treatment optimization and modelling).
- Special flour development.
- Whole grain milling (wheat, barley, buckwheat) (currently 1%) (taste, safety, quality, color, nutrition, stability).
- Value-added products development from high-ash flour and by-products.
Thank you!