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Single and double high grinding at first and second break in a wheat flour milling system

1. Flour Milling and Importance of Break Passages B1/2
2. Aspects on Double Grinding
3. Intensive short milling and conclusion

KSU Dept. Grain Science and Industry
Manhattan KS, Nov. 09.2010

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Flour Milling and B1/2

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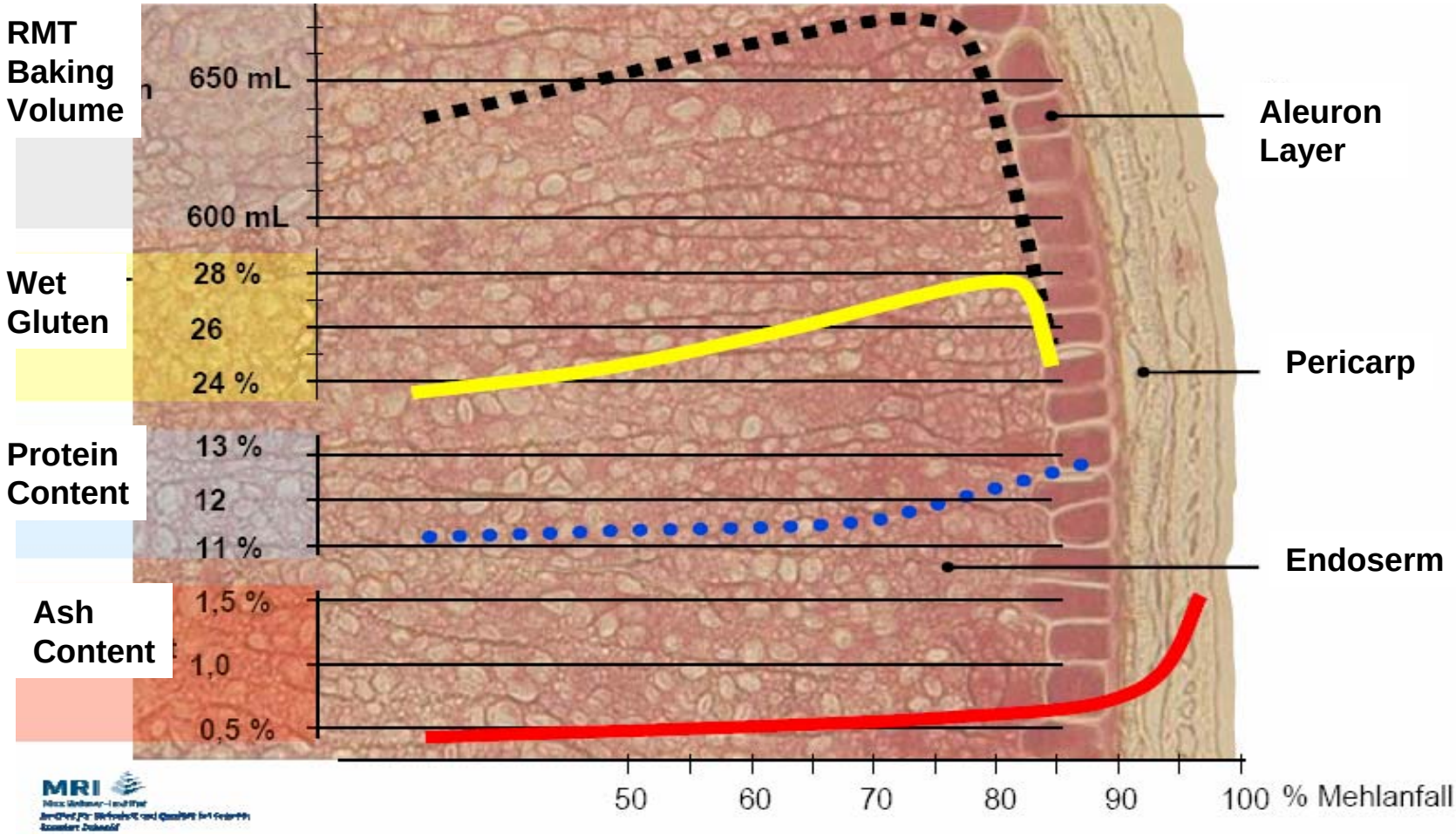
Composition of Wheat and Aim of Flour Milling



Flour Milling and B1/2

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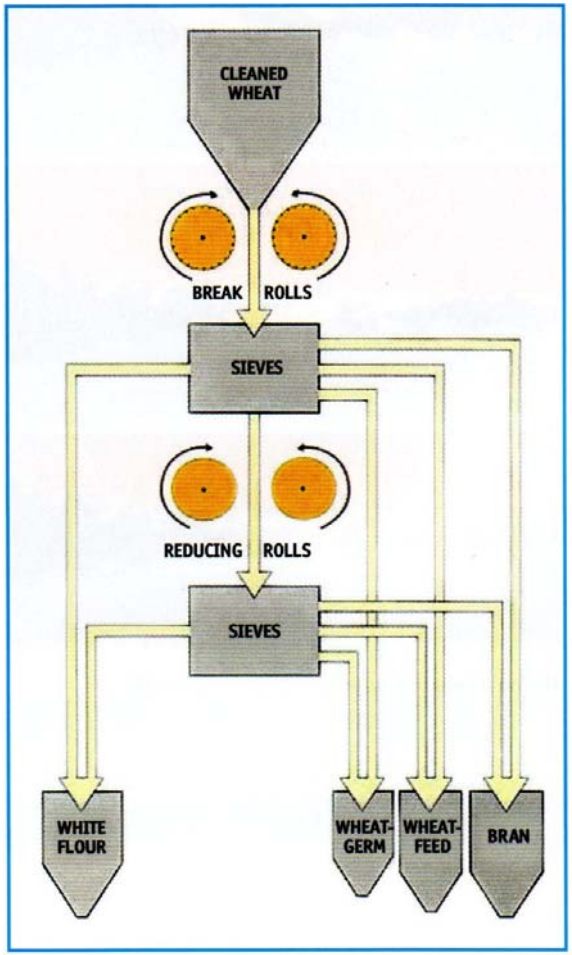
Simplified diagram of the milling process

"Dry Milling is an ancient art ….. and is the attempt to separate the anatomical parts of the grain as cleanly as possible"
(C.R.Hoseney 1986)

Milling Process

- Grain Cleaning
- Tempering and Conditioning
- Milling in Passages
  - Grinding with roller mills
  - Separating with sifters and purifiers
  - Creating types of flour by Homogenizing and/or Blending



Source: Future of Flour 2006

Main Objective of Flour Milling

1. **Objective is to remove the bran and germ from the endosperm**

   - **No coarse/fine grinding but SELECTIVE Grinding**

   - This is done, for the most part, with the break system of the mill
     B-passages grind the grain kernels into flour, semolina, middlings and bran

2. **Objective is to reduce the endosperm to flour fineness**

   - This is accomplished by the reduction system
     C-passages reduce the ground stock in several steps into flour,

   - After each grinding the ground stock is separated on sieves and by air separation
     by **sifting** with plansifters; flour, semolina, middlings and break stock are separated
     by **purifying,** bran particles are separated from semolina

Flour Milling and B1/2

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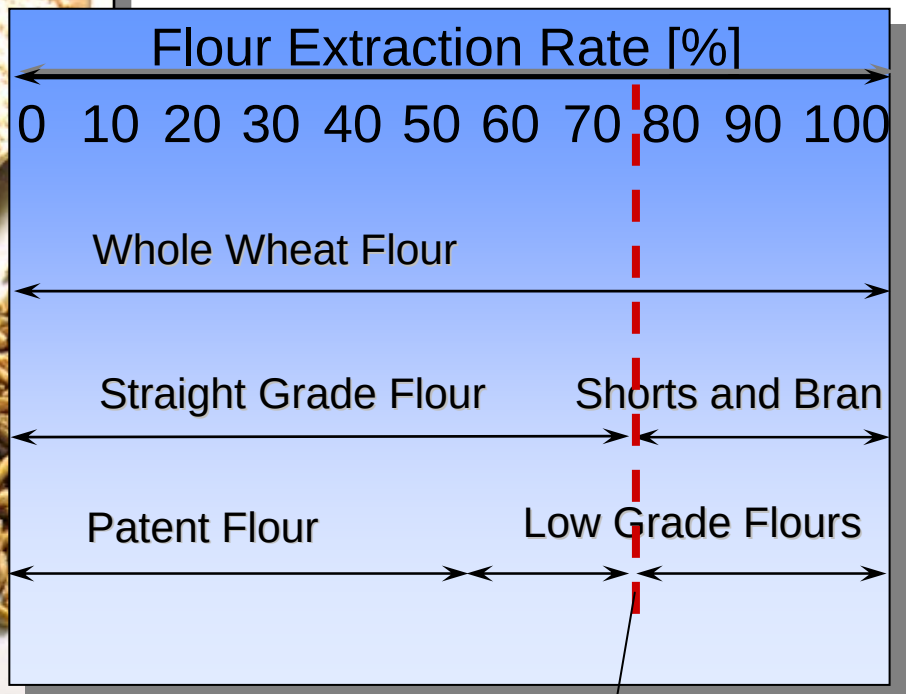
Grades of Flour obtained from Wheat

Flour Milling



ca.
75 – 80%

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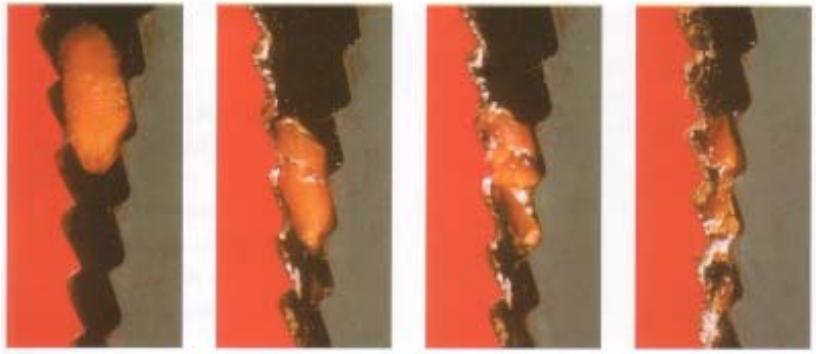
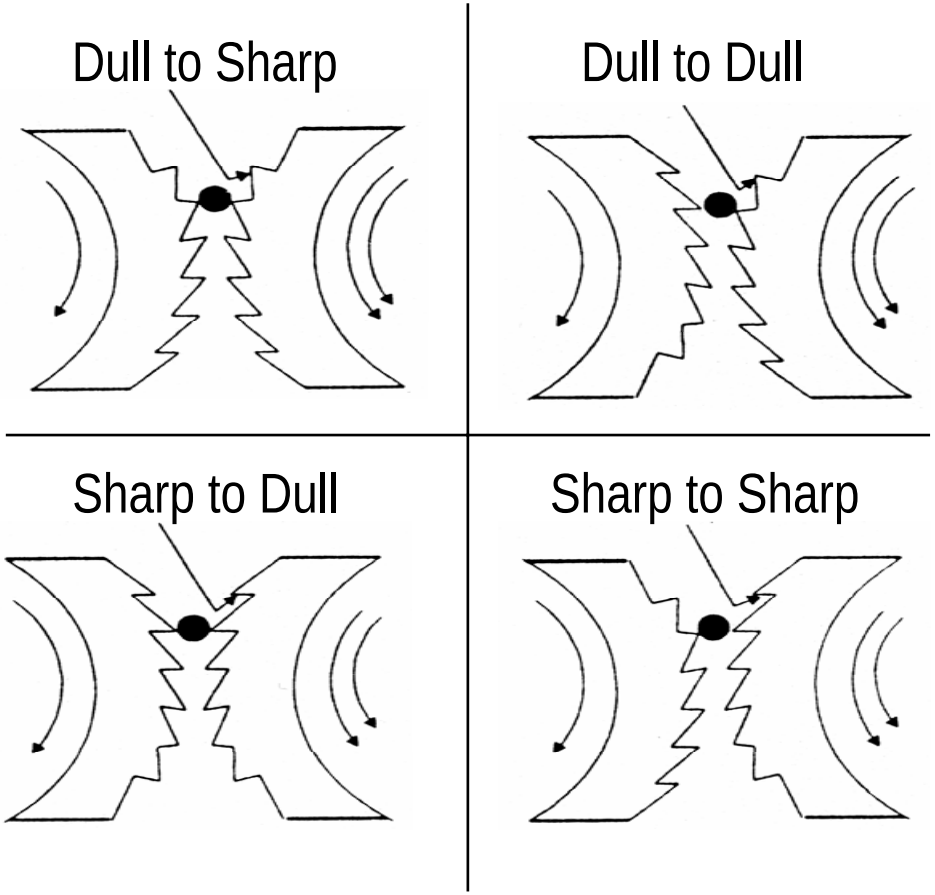
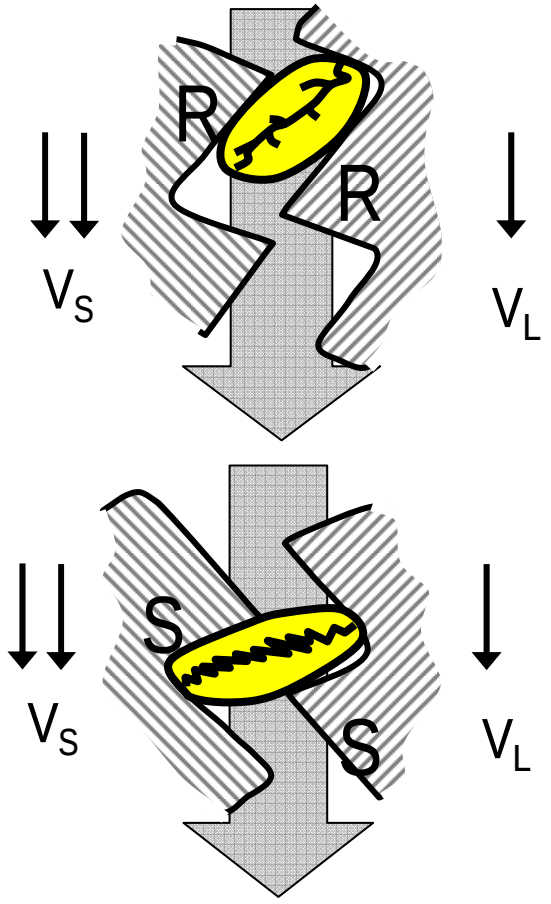
Break System

- Break systems are **most important** for the efficiency of the flour mill
- Break system consists of **four or five breaks** (sets of rolls)
- Break rolls are always **corrugated** varying from coarse to fine
  (In comparison to the reduction system, where rolls are generally smooth)
- With the early breaks **B1/2** the endosperm is taken off in rather large pieces
- With later breaks **B3-5** the action is more like scraping the bran



Corrugation of rolls





Flour Milling and B1/2

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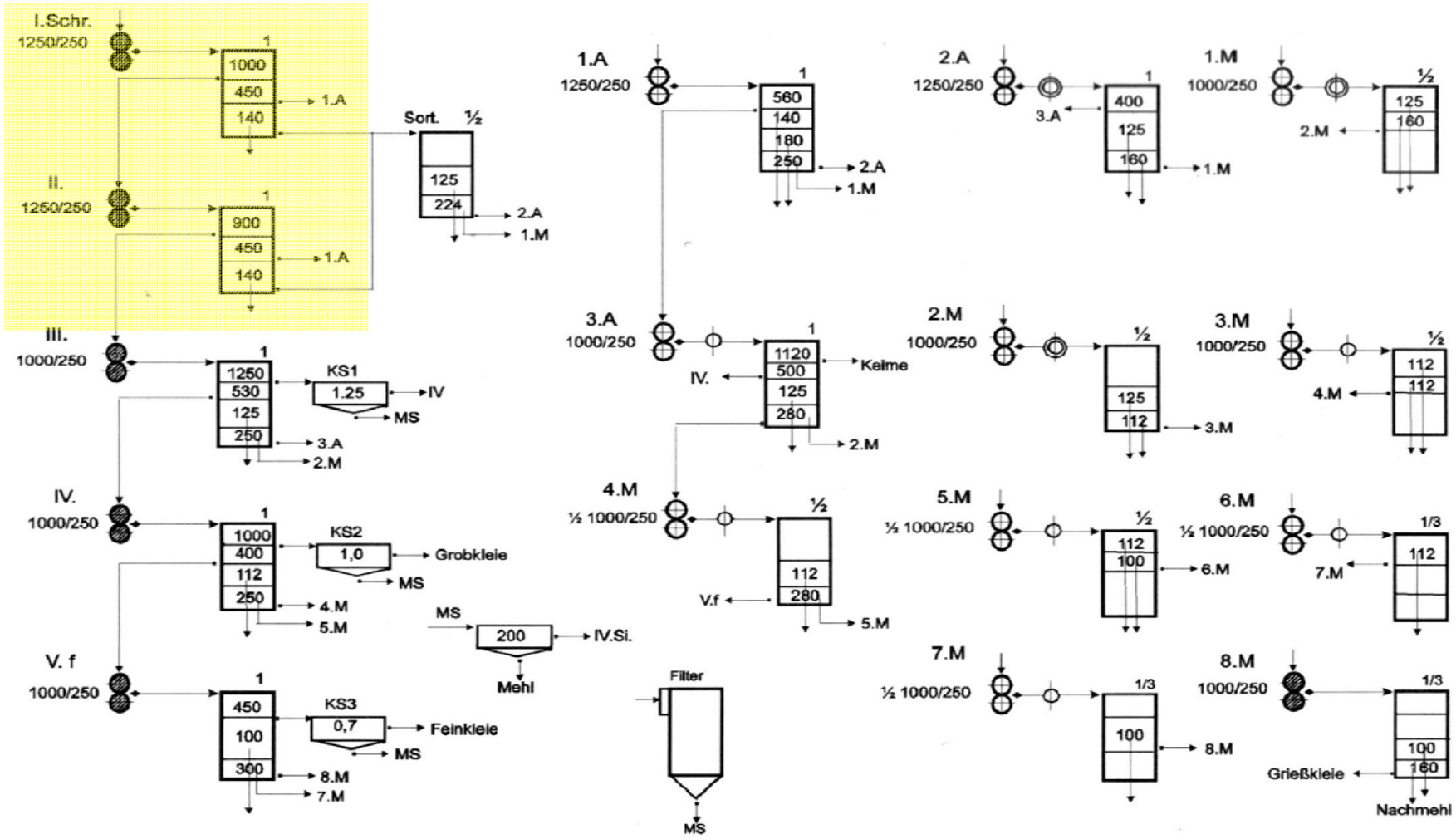

Source: Handbuch Müllerei 2006

Double Grinding

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Roll parameters

	Walzen						Riffel						Glatt.	Speisung			Übertrieb		Antrieb	
Passage	Anzahl	Länge	Durchmesser	Dickwandig	Wasserkühlung	Aut. Mahlsp. ver	Anzahl / Umfang	Anzahl / cm	Stellung	Form	Drall x	Scheitelb. / mm	Bombierung / µ (auf Durchm.)	Typ vorn	Typ hinten	Verteilbrücke	Zahnriemen Übersetzung	Abstreifer Typ	t / Min.	Motor / kW
B1	4	1250	250				250	3,2	D	18	6	0,2		S2	·		1 : 2,5	·	560	
B2	4	1250	250				325	4,1	D	18	6	0,2		·	·		1 : 2,5	·	560	
B3	4	1250	250				500	6,4	A	69	8	0,1		PT7	W		1 : 2,5	B	560	
B4 gr.	2	1000	250				675	8,6	A	69	8	0,1		PT7	W		1 : 2,5	B	560	
B4 f.	2	1000	250				750	9,6	A	69	8	0,1		PT5	W		1 : 2,5	B	560	
B5 gr.	2	1000	250				800	10,2	A	69	10	0,1		PT7	W		1 : 2,5	B	500	
B5 f.	2	1000	250				850	10,8	A	69	10	0,1		PT5	W		1 : 2,5	B	500	
C1 A	4	1250	250										60 - 65	S7	S1	x	1 : 1,23	M	560	
C2 A	4	1250	250										60 - 65	·	·		1 : 1,23	M	560	
C1 B	2	1000	250										40 - 45	S7	S1	x	1 : 1,23	M	560	
C2 B	2	1000	250										40 - 45	S7	S1	x	1 : 1,23	M	560	
C3	4	1000	250										30 - 35	S7	S1	x	1 : 1,23	M	500	
C4	2	1000	250										30 - 35	S7	S1	x	1 : 1,23	M	500	
C5	4	1000	250										30 - 35	S7	S1	x	1 : 1,23	M	500	
C6	2	1000	250										30 - 35	S7	S1	x	1 : 1,23	M	500	
C7	2	1000	250										30 - 35	S7	S1	x	1 : 1,23	M	440	
C8	2	1000	250										30 - 35	S7	S1	x	1 : 1,23	M	440	
C9	2	1000	250										30 - 35	S7	S1	x	1 : 1,23	M	440	
C10	2	1000	250				1100	14,0	A	69	10	0,1		S7	S1	x	1 : 2,5	M	440	

Source: Handbuch Müllerei 2006

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Influences to the design of the milling diagram

1. Wheat Quality and Specification

   - Wheat **quality** (Class, grade, variety, uniformity)
   - Wheat **hardness** (accord. to hardness test for determination of ideal grinding moisture, in the US HRW, HRS, DNS, Grade 1-5, in Germany E,A,B,C,K)

2. Specification of final product range and quality

   - **Range of flours** (patent, straight-grade, low grade flours accord. to ash content)
   - **Semolina range**

   but also
   - bran **specks** in the flour (frozen pre-dough)
   - **starch damage** (particle size) and **water absorption**

Flour Milling and B1/2

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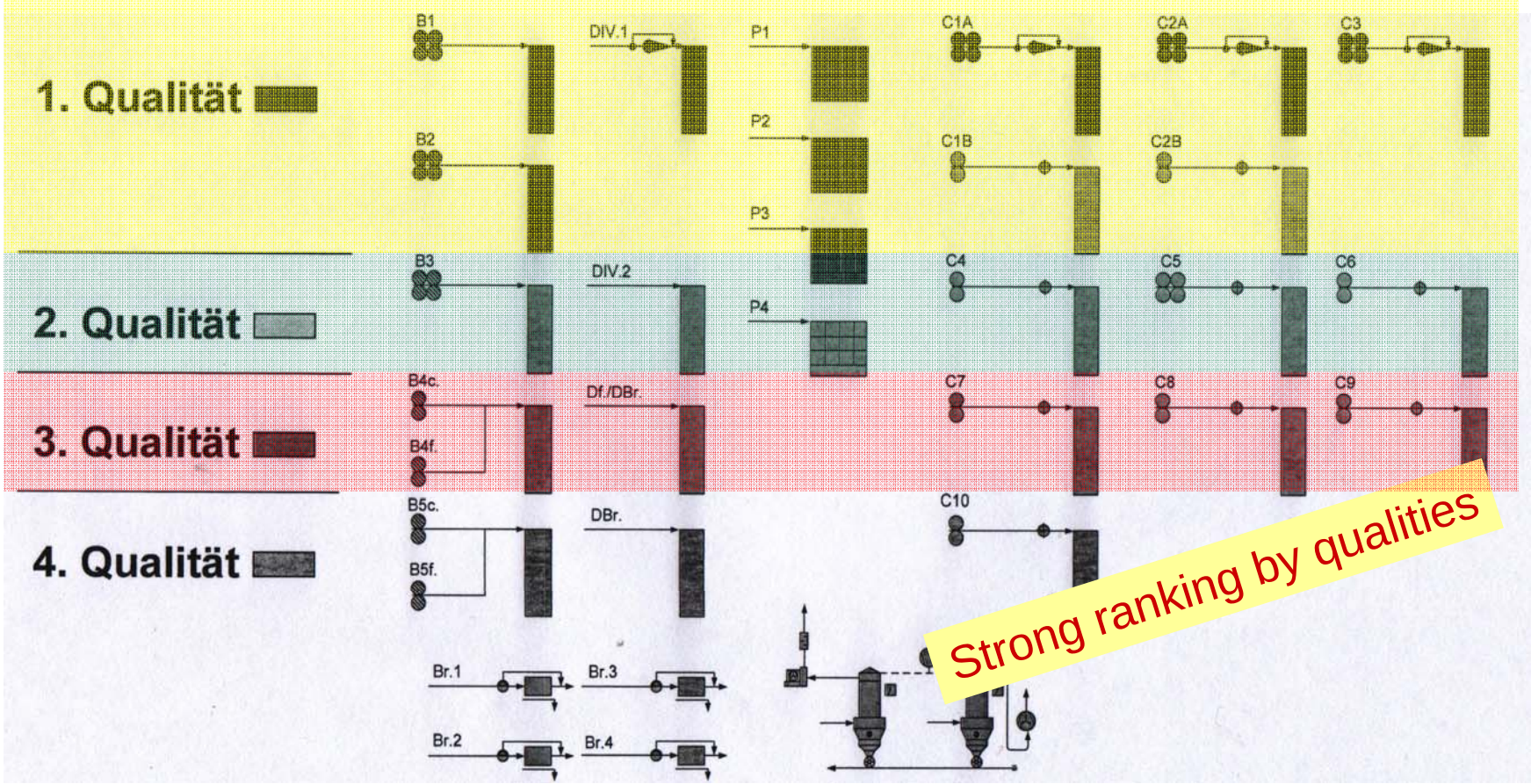
Mill Diagram according to flour quality



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Influences to the design of the milling diagram

1. Wheat quality

- The lower the quality the more efficient should be the cleaning and milling diagram

2. Wheat hardness

- The higher the hardness, the more it needs semolina producing break passages (more roll length in B1/2 similar to Durum milling)
- The lower the hardness the more it needs gentle grinding in the break system (more passages)

3. Flour Quality

- The higher the yield of light and patent flours, the more roll length is required with the break system
- The more clean (speck-free) the flour and semolina, the more purifiers are necessary

Flour Milling and B1/2

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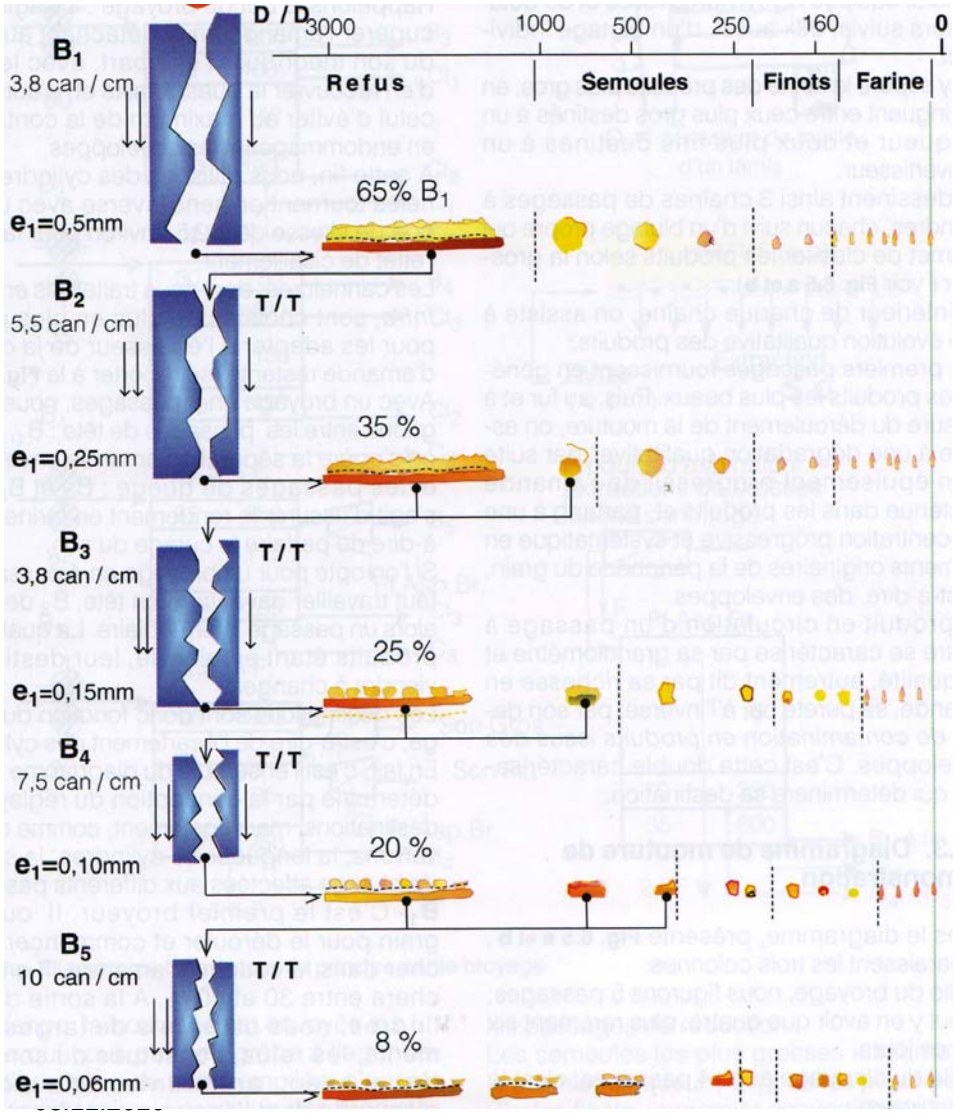
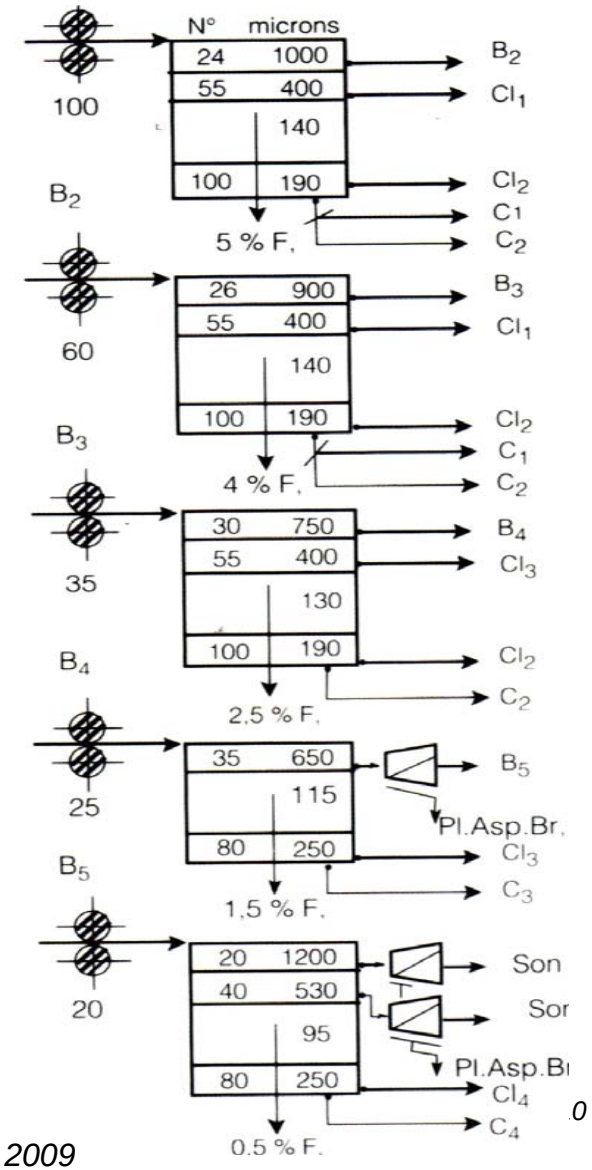
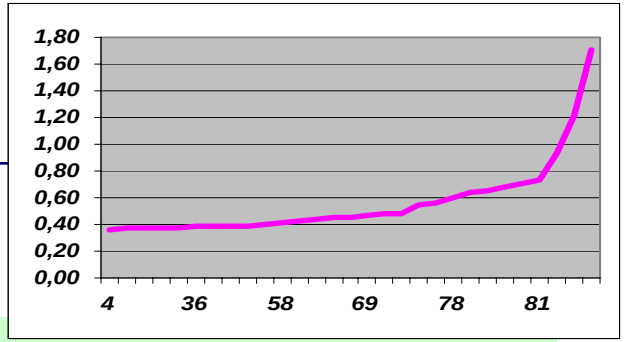




Source: Willm 2009

Flour Milling and B1/2



Passage Analysis and importance of B1 and B 2

pass	yield%	ash%	ashproduct	ashproduct commulated	yield% commulated	mix ash%
C2 I	4	0,36	1,44	1,44	4	0,36
C2 II	10	0,37	3,7	5,14	14	0,37
C1 I	3	0,38	1,14	6,28	17	0,37
C1 II	7	0,39	2,73	9,01	24	0,38
C3 I	8	0,39	3,12	12,13	32	0,38
C3 II	4	0,41	1,64	13,77	36	0,38
C5	5	0,41	2,05	15,82	41	0,39
B2	**5**	**0,43**	2,15	17,97	46	0,39
C5 II	1	0,45	0,45	18,42	47	0,39
Gr.	5	0,46	2,3	20,72	52	0,40
B1	**6**	**0,50**	3	23,72	58	0,41
C6 I	3	0,70	2,1	25,82	61	0,42
C4 I	3	0,74	2,22	28,04	64	0,44

Source: Handbuch Müllerei 2006

Flour Milling and B1/2

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Importance of B1/2

- Break system consists of **four or five breaks** (sets of rollers)
- Break rollers are always **corrugated** varying from coarse to fine
  (In comparison to the reduction system, where rollers are generally smooth)
- With the early breaks **B1/2** the endosperm is taken off in rather large pieces
- Producing approx. **50-60% semolina and 10 -15% flour Grade 1**
- With later breaks **B3-5** the action is more like scraping the bran

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Double Grinding

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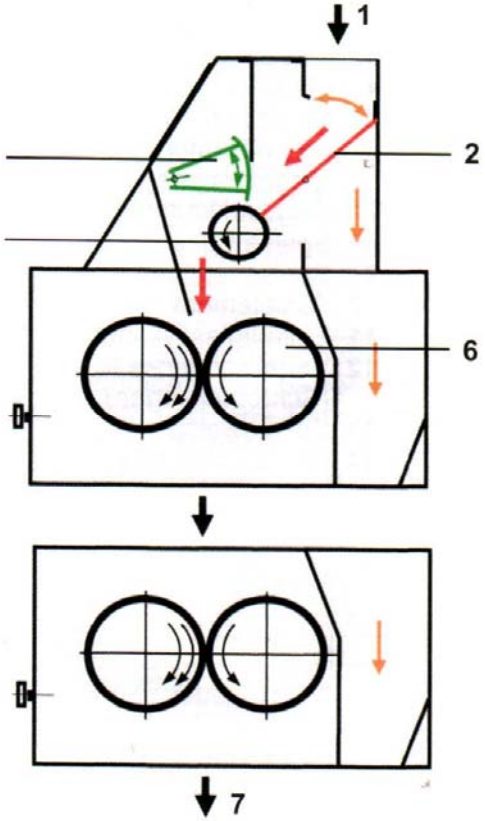
Four Roller Coarse Grinding Mill in Feed Milling



1 Produkteinlauf, **2** Umgehungsklappe, **3** regulierbarer Segmentschieber, **4** regulierbare Speisewalze, **5** Mahlspalteinstellung, **6** Walzenpaket (Riffelwalzen), **7** Produktauslauf

Source: Buhler

Double Grinding

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Malt Grist Mill

with Six Roller Mill

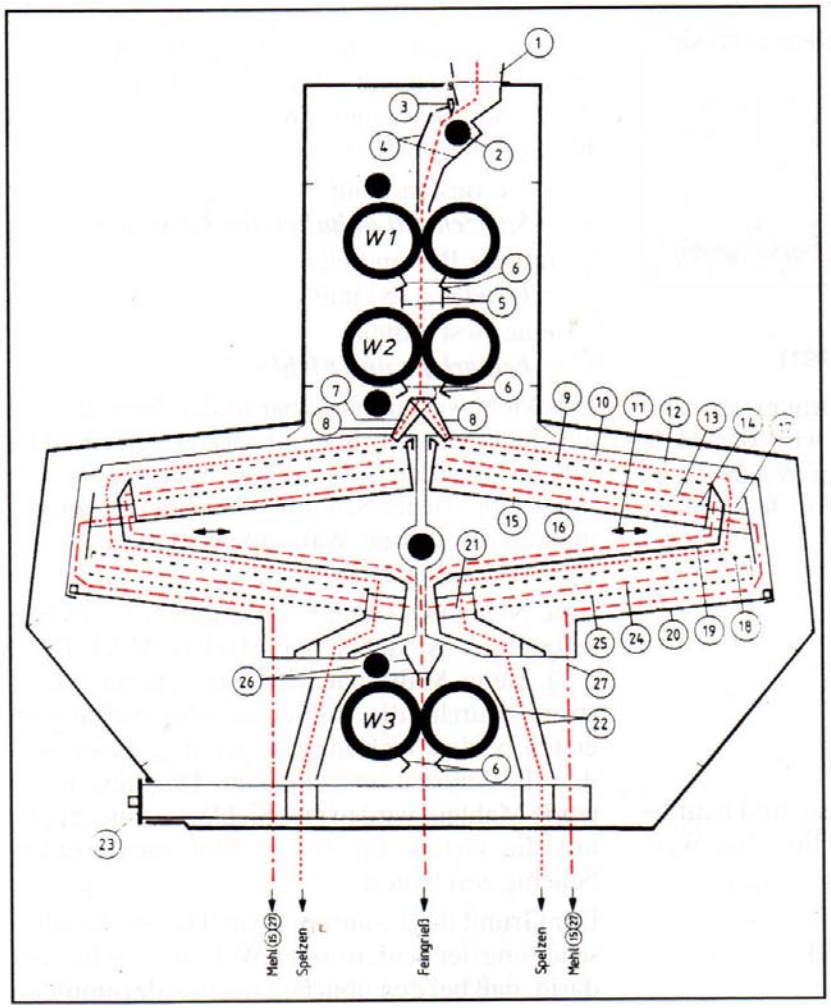

Bild 3.7
Sechswalzenmühle „Maltomat" (Prinzip)

(W 1) Vorbrechwalzenpaar
(W 2) Spelzenwalzenpaar
(W 3) Grießwalzenpaar
(1) Malzeinlauf
(2) Speisewalze
(5) Leitbleche
(6) Abstreifer
(10) Schrot
(13+24) Grieße
(15) Mehl
(23) Probennehmer

Source: Mälzerei/Brauerei 1996

Double Grinding

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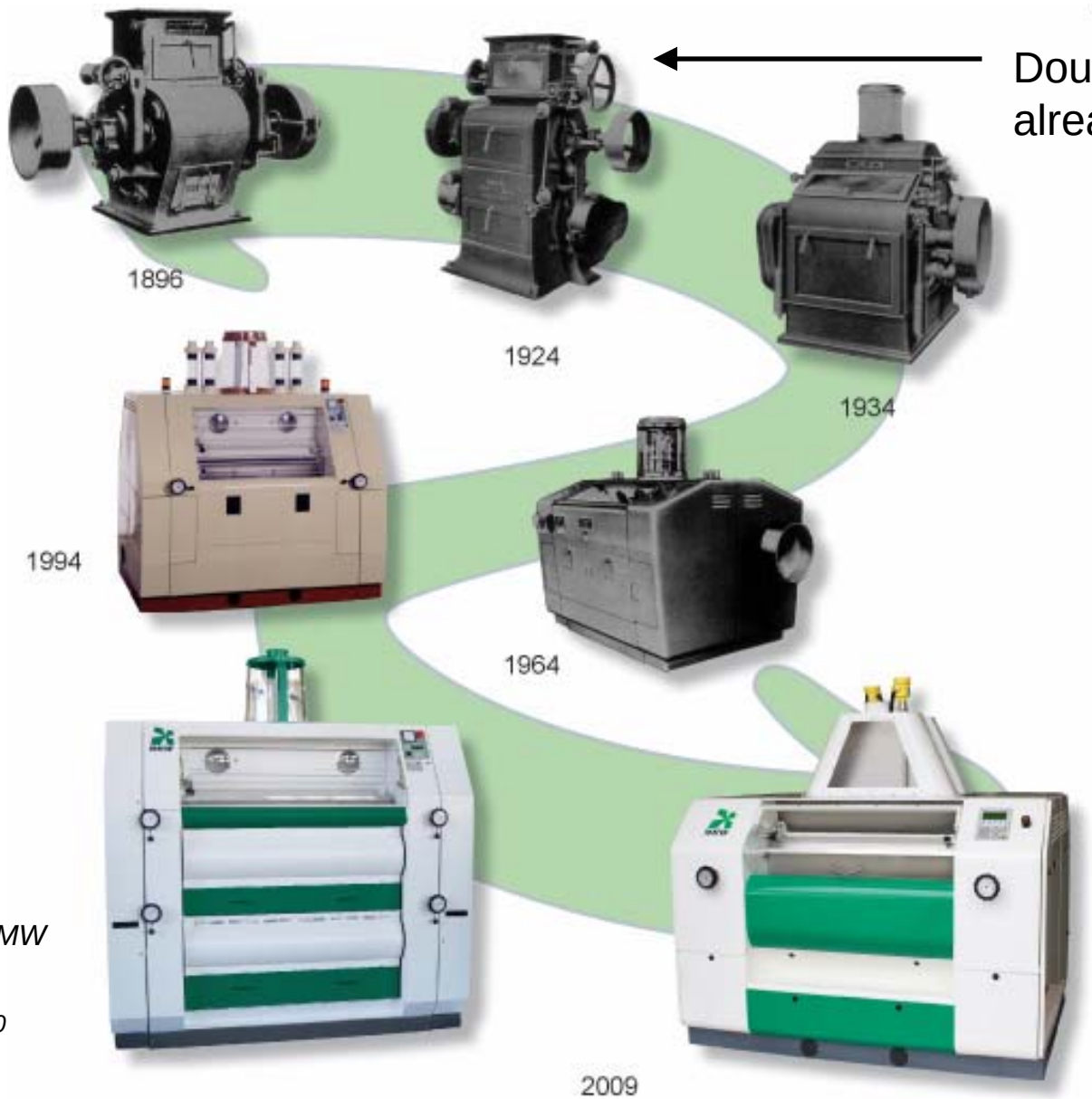

Double Pass RM
already in use in 1924

Source: MMW

Double Grinding

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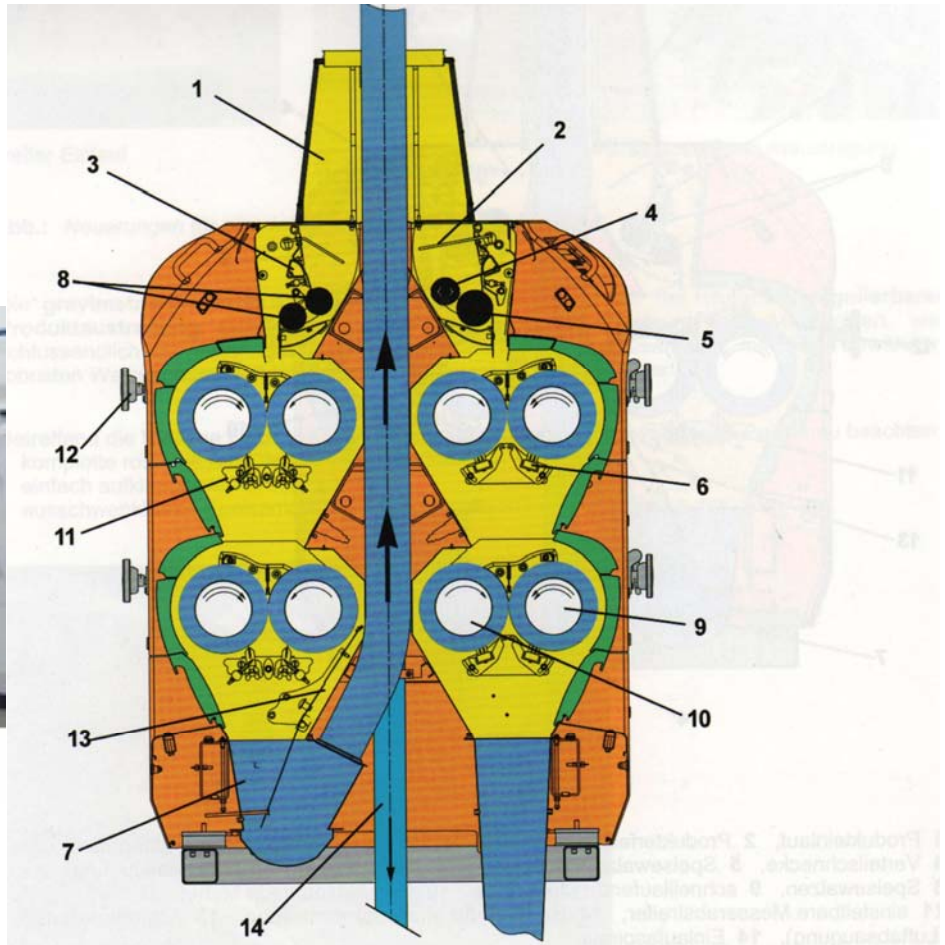
Modern Roller Mill and 8 RM

Source: Buhler



1 Produkteinlauf, 2 Produkterfassung (gravimetrisch mit Biegestab), 3 Speisesegment, 4 Verteilschnecke, 5 Speisewalze, 6 Bürstenabstreifer, 7 Trimelle (Direktabsaugung), 8 Speisewalzen, 9 schnelllaufende Mahlwalze, 10 langsamlaufende Mahlwalze, 11 einstellbare Messerabstreifer, 12 Handrad für Mahlspaltverstellung, 13 Aspirationskanal (Luftabsaugung), 14 Einlaufaspiration

Double Grinding

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Arguments of the suppliers

Perfect Grinding
Uniform distribution of the product and feeding to the grinding rollers creates the conditions for perfect grinding.
The self-contained roller pack excels through its high accuracy of adjustment and grinding stability: The optimal prerequisite for top product quality and yield.
Highest sanitation standards for guaranteed product safety
Stainless steel linings and ingenious insulation and ventilation solutions guarantee highest product safety and sanitation.
Easy access via swing-open panels as well as a swing-out feed module allow for quick and thorough cleaning.
Extremely reliable – 24h / 365 days
The compact roller pack and innovative frame construction, guarantee superior dependability in around-the-clock operation at a constant grinding quality.
Soundproofing of the panels results in significantly quieter operation.
Superior design
The unique machine design is an attention-grabber in every plant, underscoring the perfection.

Source: Buhler

Double Grinding

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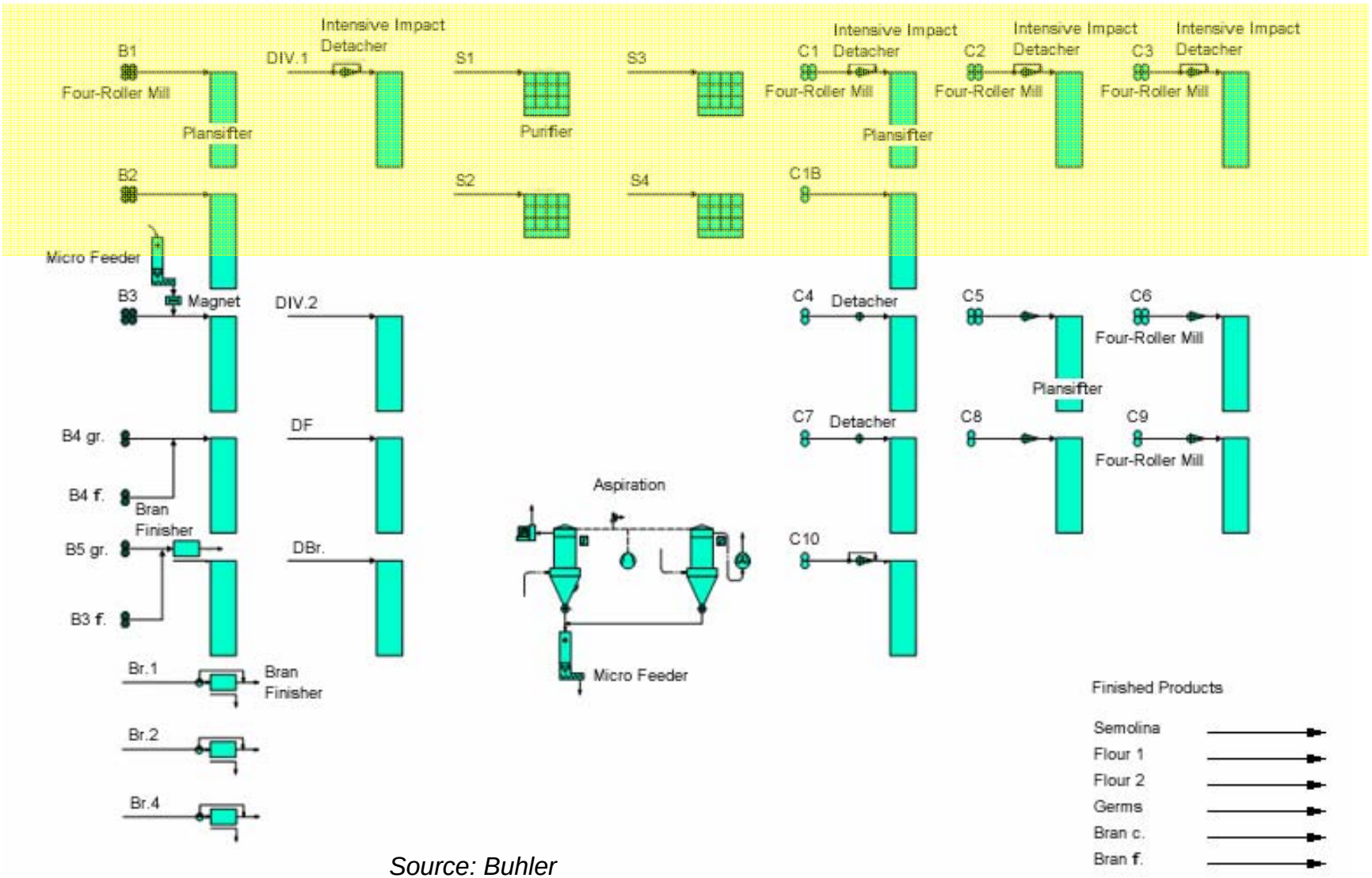

Source: Buhler

Double Grinding

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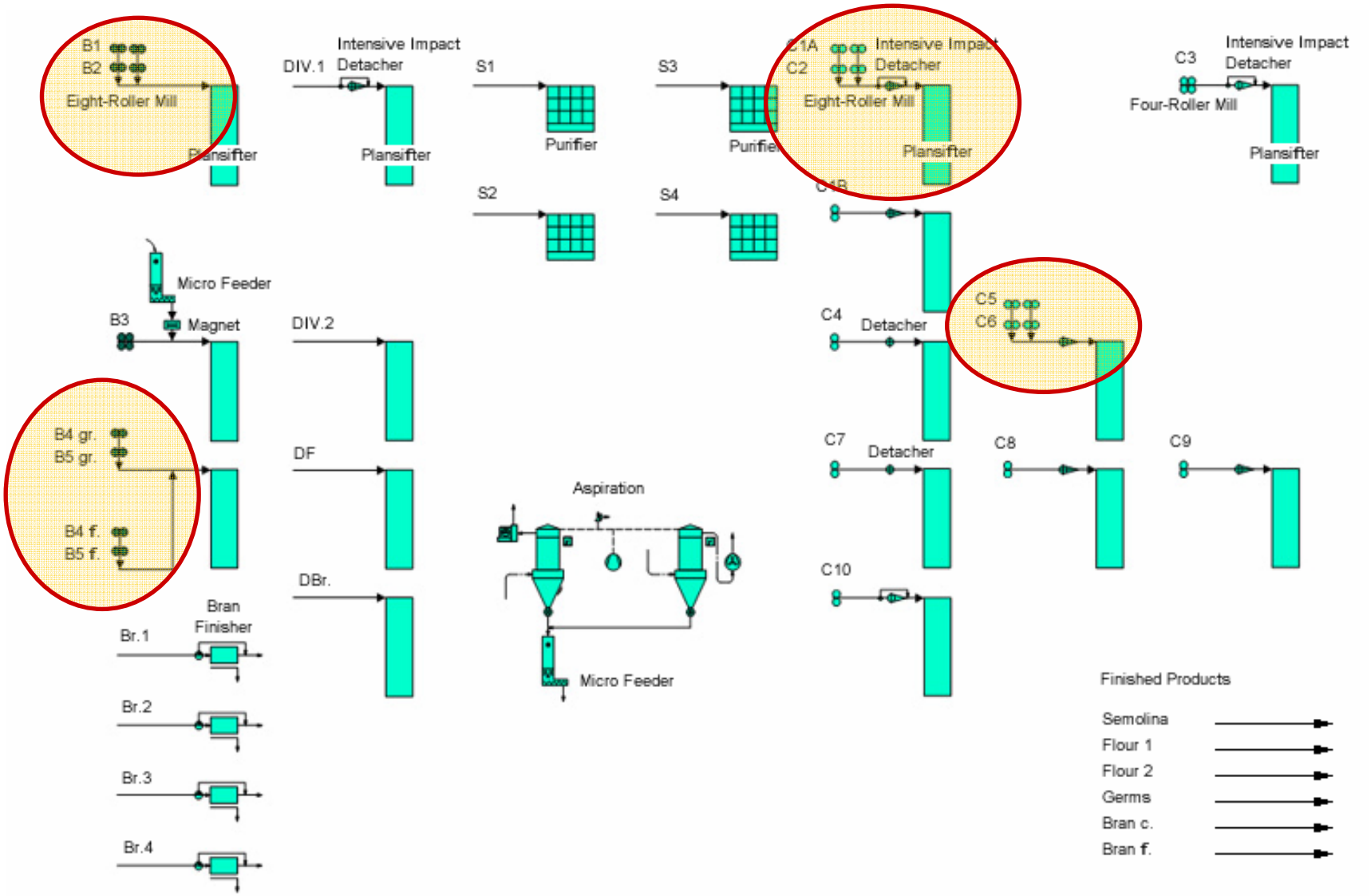

Source: Buhler

Double Grinding

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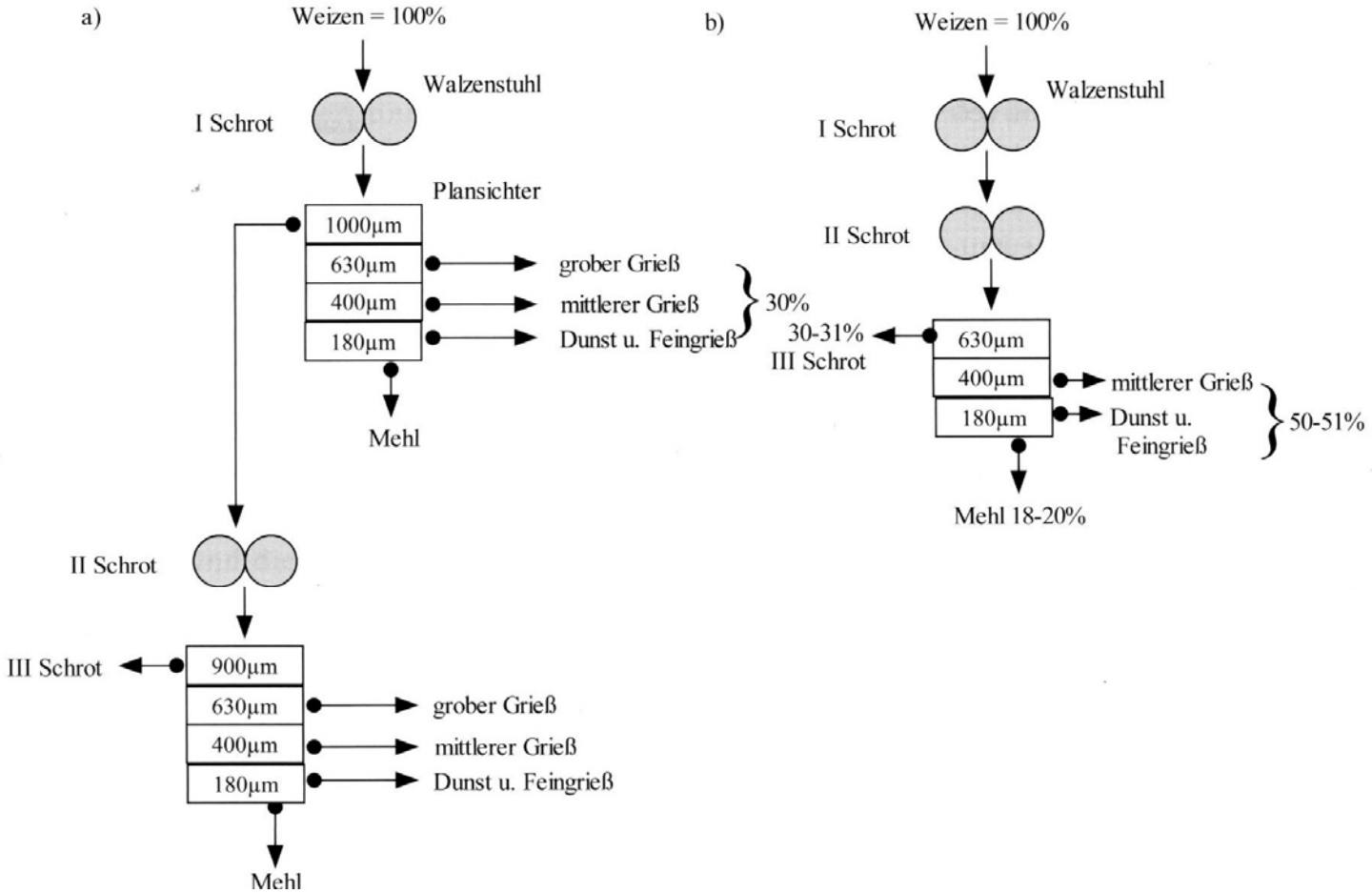
Experimental Investigation for Double Grinding



Source: Handreck 2007

Double Grinding

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Comparision of B1 and B2 vs. B1/2

*** Upgrading by purifying**

Fraction	B1 and B2		Double Grinding B1/2	
µm	Total (%)	Ash Content (%i.Tr.)	Total (%)	Ash Contentt (%i.Tr.)
> 1000	36,9	2,82	23,0	3,972
630 –1000	20,9	1,25	8,1	3,082
400 – 630	18,8	0,505	**26,0***	0,613
200 – 400	12,6	0,468	**24,9**	0,456
< 200	10,9	0,461	**18,1**	0,457
< 630	**42,3**	**0,488**	**69,0**	**0,515**
200 - 630	31,4	0,517	49,9	0,547
> 630	57,8	2,25	31,1	3,703

23,5 %

43%

Source: Handreck 2007

Double Grinding

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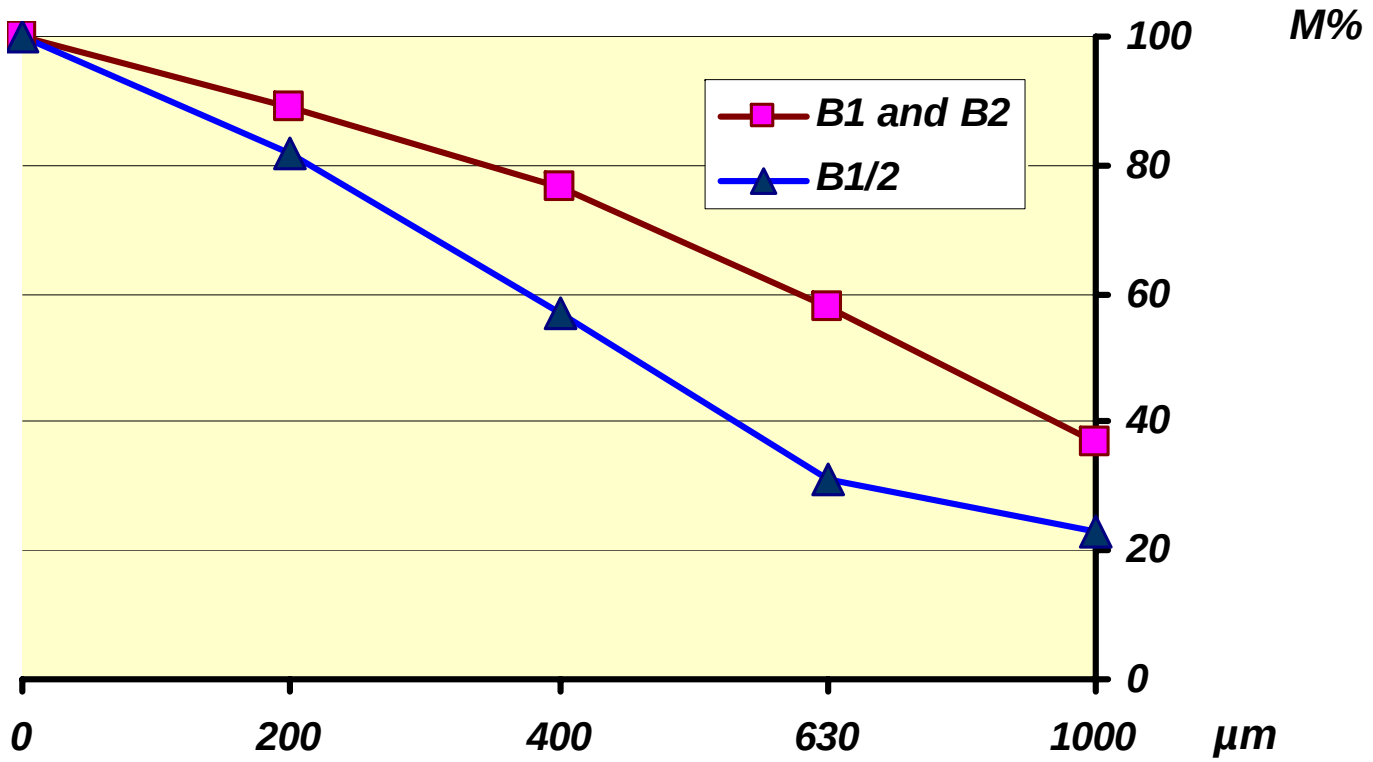
Comparision of B1 and B2 vs. B1/2 sieve analysis



Double Grinding

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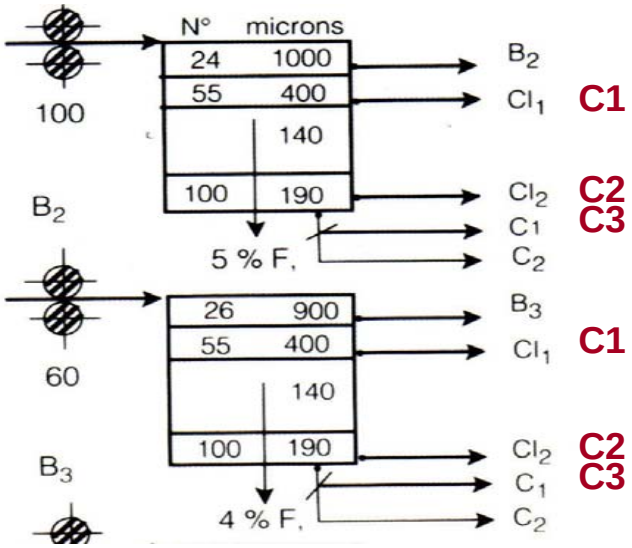
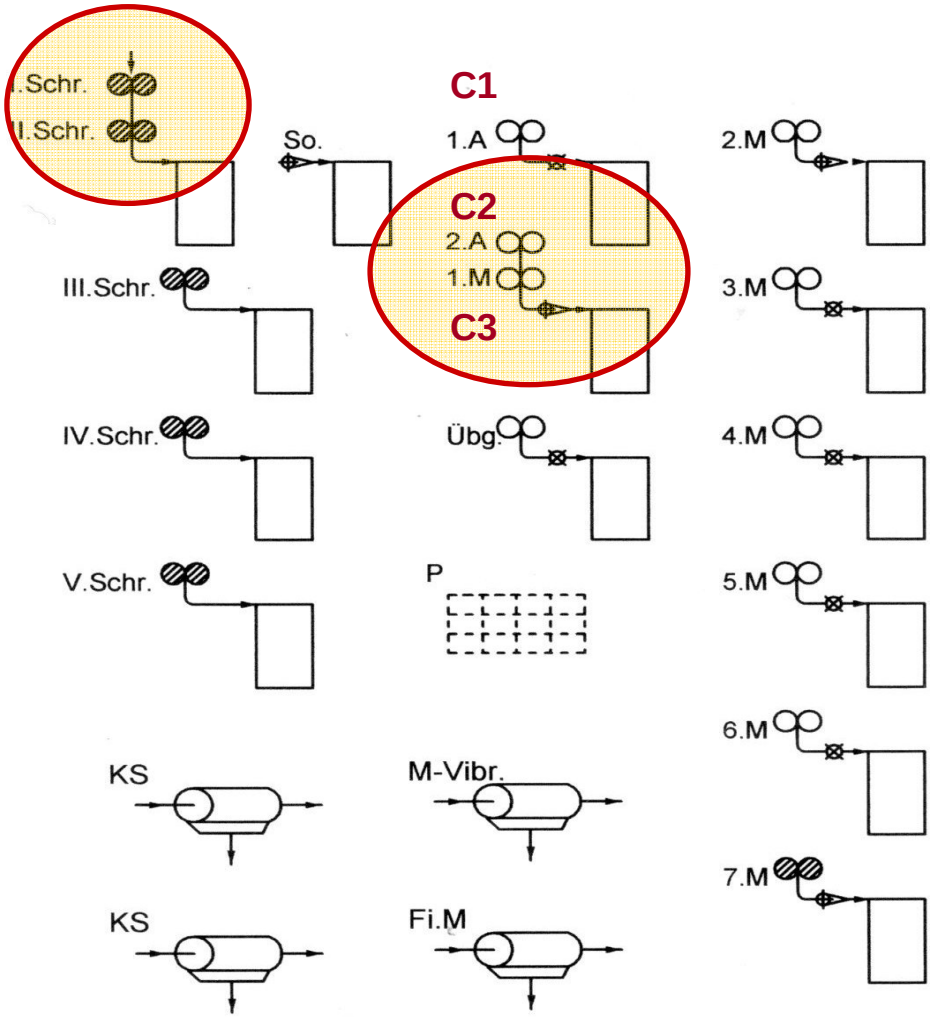
In Practice (example)

- in B 1/2 and
- In C2/C3, caused by similar particle size





Source: Zwingelberg 2003

Double Grinding

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General aspects of Double Grinding B1/2 and C1/2 (C2/3)

Advantages

- **More intensive grinding with**
  - higher yield of flour in B1/2 (up to 20%) and fine semolina (up to 25%), means higher yield of flour in first middlings (C3 ..)
- **Shortening of diagram and reducing costs of milling by**
  - Reduced number of Roller Mills
  - Fewer C passages (coarse middlings)
  - Fewer passages of Plansifters
  - Smaller requirements for pneumatic transport (air, filters, energy)
  - Reduced number of drives
  - Saving of space for the mill or
  - More capacity for the existing mill inside the existing building !!!

Double Grinding

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Example of a wheat flour mill 140t/d

Technical data	Traditional Milling	Short Milling with 8 RM
Roller Mill Places	10	8
Plansifter Parts	14	12
No. Pneumatic lines	22	18
Air consumption PN m^3/min	140	110

Source: Klabunde 2010

Double Grinding

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Comparison of Traditional and Short Milling

Technical data	Traditional Milling	Short Milling with 8 RM
Specific Roll Length mm/dt*d	18 – 24 12 - 20	10 - 12
Specific Sifting Area m²/t*d	0,9 – 1,4 0,5 – 1,0	0,4 – 0,5
Specific Purifier Width mm/t*d	30 – 40 0 - 20	0 - 16
Specific Power Consumption kWh/t	55 – 60	40 - 45

Source: Handreck 2005

Double Grinding

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General aspects of Double Grinding B1/2 and C1/2 (C2/3)

Other aspects and limitations

- In each of the double passages **only one** type of flour
  - Limitation if milling different types of flour
  - With B1/2 no chance of separating B1 flour (low protein) and B2 flour (higher protein)

- **Less yield of semolina**
  - Less coarse but more fine semolina caused by grinding in B2
  - With C2/3 more fine flour (particle size reduced)

- **Limitation of passage combinations** and diagrams
  - Lower rollers of 8 RM only get the stock from the upper level
  - No chance to feed with stock from other passages

- **Roller mill adjustment** is different
  - 100% of B1 goes to B2 with smaller gap and smoother corrugation
  - Danger of overloading B2, special detection and control needed

Double Grinding

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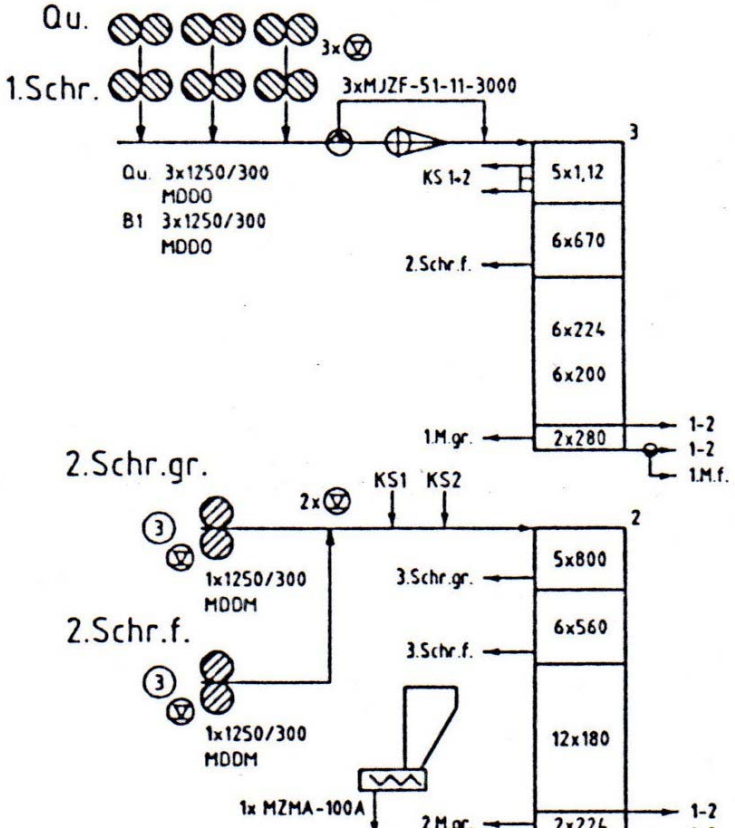
Double Grinding in Rye Milling

- Rye is tougher than wheat and needs prebumping especially for cleaning the crease
- Ergot has to be removed by effective cleaning
- Double grinding in an 8 RM for rye flours > 0,9% ash content as a combination of pre-bumping and B 1
- Double grinding or impact mill grinding for dark and/or whole grain flours



Source: SCC 2006

Double Grinding

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General Remarks

- B 1/2 are highly important for the efficiency of the mill and have to be adjusted to produce high yield of semolina and speck-free low ash flour of 1. quality
- Double Grinding can give higher yield of flour in B1/2 (up to 20%) and fine semolina (up to 25%), means higher yield of flour in first middlings (C3 ..)
- Double grinding has gained acceptance for aspects of reducing/simplifying the diagram and has been used mainly in B 1/2 and first C passages
- Double grinding can be recommended for milling of flours with ash content > 0,50%, whereas high yield lower ash flours < 0,50% still should be produced by single grinding diagrams

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Intensive Short Milling

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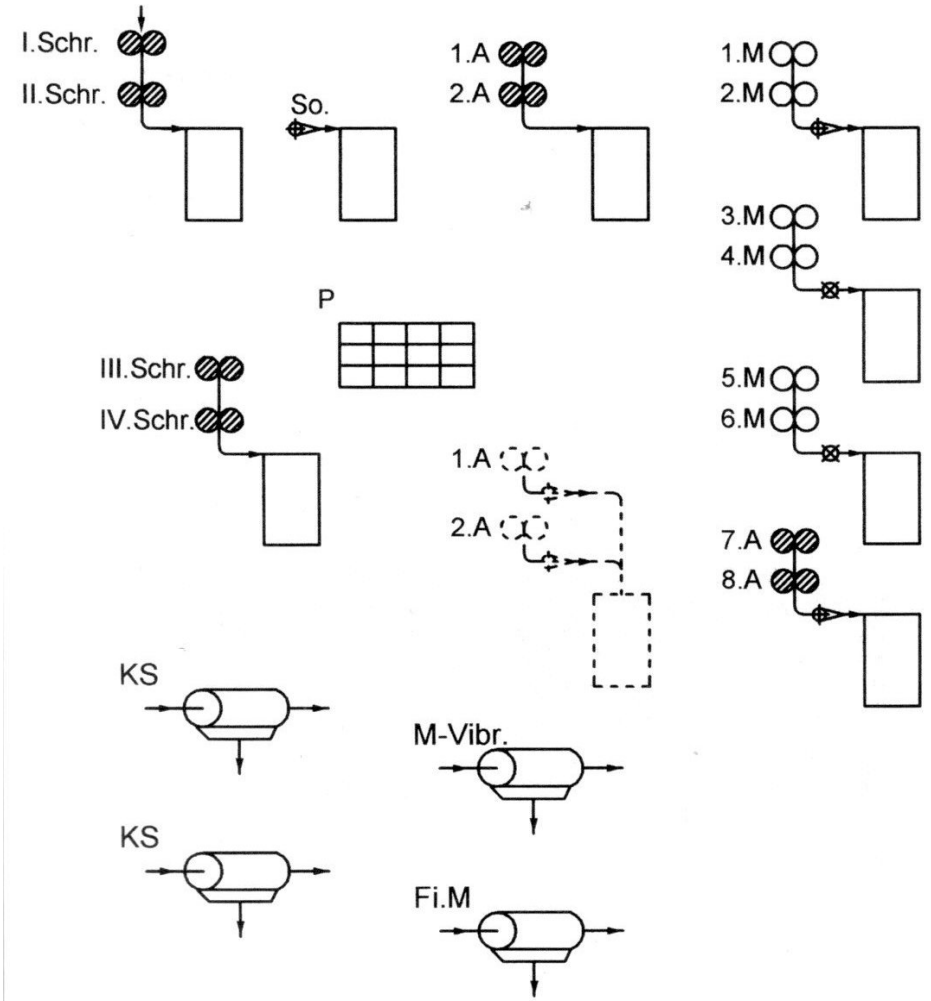
Exception with only 8 RM

- For flours with ash content > 0,60% (2.Grade)
- C1/2 with corrugated rollers
- Need to find compromises to the adjustment of each double passage
- Supporting grinding and sifting with impact detacheurs and vibro bran/flour finishers



Source: Zwingelberg 2003

Intensive Short Milling

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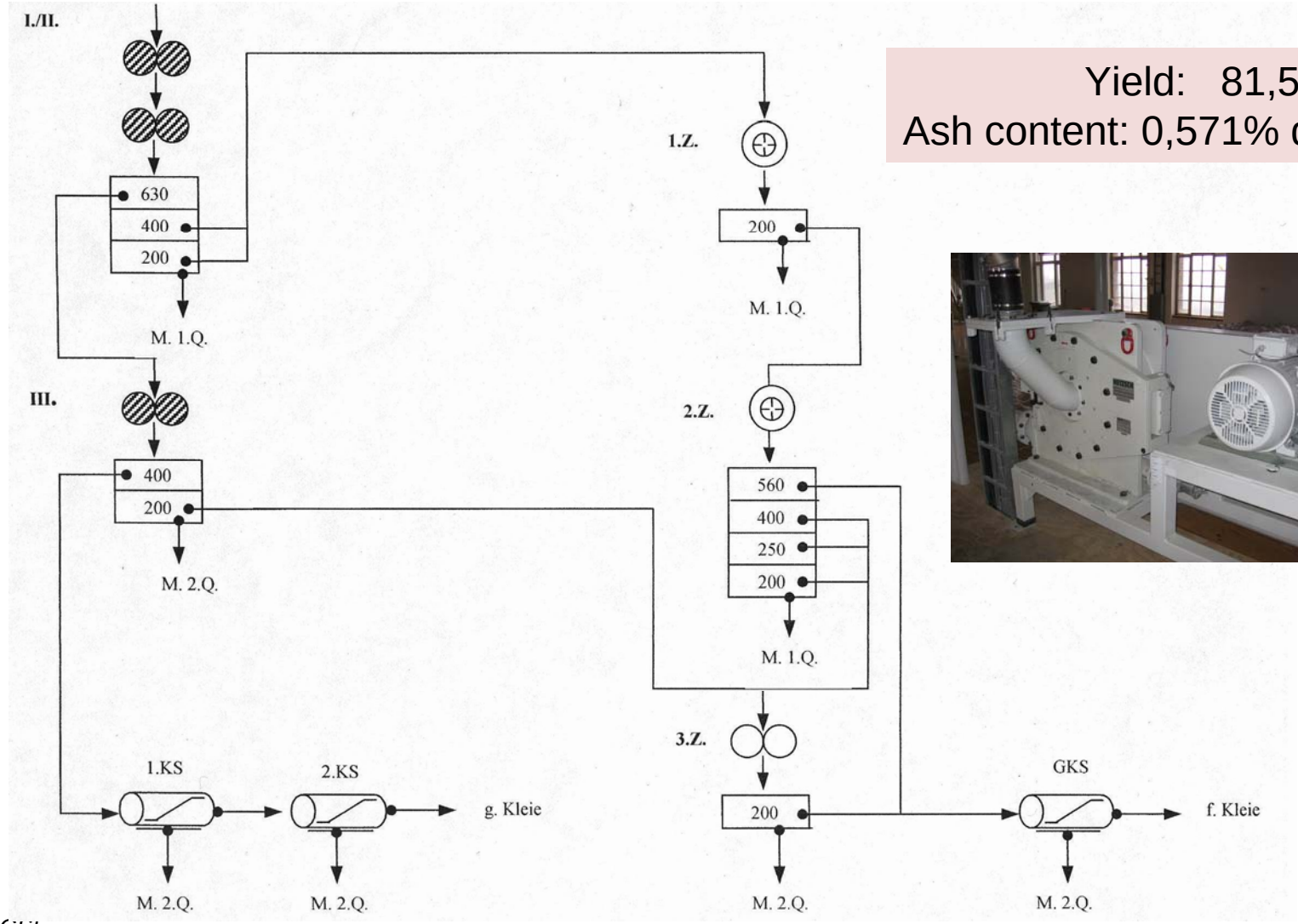

Yield: 81,55%
Ash content: 0,571% d.b.

Source: Handreck 2005

Intensive Short Milling

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Comparison of Traditional and Short Milling

	Modern Milling			Intensive Short Milling		
Break	**Semolina (%)**	**Flour (%)**	**Σ (%)**	**Semolina (%)**	**Flour (%)**	**Σ (%)**
I	**27**	**6**	**33**	**-**	**-**	**-**
II	**21**	**7**	**28**	**51**	**19**	**70**
III	**11**	**5**	**16**	**4**	**7**	**11**
IV	**5**	**3**	**8**	**-**	**-**	**-**
V	**4**	**2**	**6**	**-**	**-**	**-**
Σ	**68**	**23**	**91**	**55**	**26**	**81**

Source: Handreck 2005

Intensive Short Milling

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Comparison of Traditional and Short Milling (with impact mills)

Passages	Modern Milling	Intensive Short Milling
Break Systems	3 - 5	3 - 4
Sorters	1 - 2	-
Purifiers	0 - 2	0 - 1
Sizings (C1,2,)	2 - 4	1 - 2
Middlings (C3 …)	7 - 10	3 - 4

Source: Handreck 2005

Double Grinding

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Conclusion and Recommendation

- Double grinding has gained acceptance in respect of reducing/simplifying the diagram with high capacities and has been used in B 1/2 and first C passages
- Double grinding can be recommended for milling of flours with ash content > 0,50%, whereas high yield lower ash flours < 0,50% still should be produced by single grinding diagrams
- For high capacity mills it should be good to install 2 lines, one traditional (for whole range of flours and flexibility) and one with double grinding (for straight grade flours)
- To shorten the diagram further, think also about other ways like de-branning
- Please keep in mind: Excellent Milling at all times means finding the right technological compromises

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Thank you for your attention,
I wish you success and luck for your study

Thomas Strandt

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