АГЕНЦИЈА за ЕНЕРГЕТИКУ
РЕПУБЛИКЕ СРБИЈЕ

PROCEDURE FOR CONVERSION OF natural gas volume to standardized conditions for metering points without corrector

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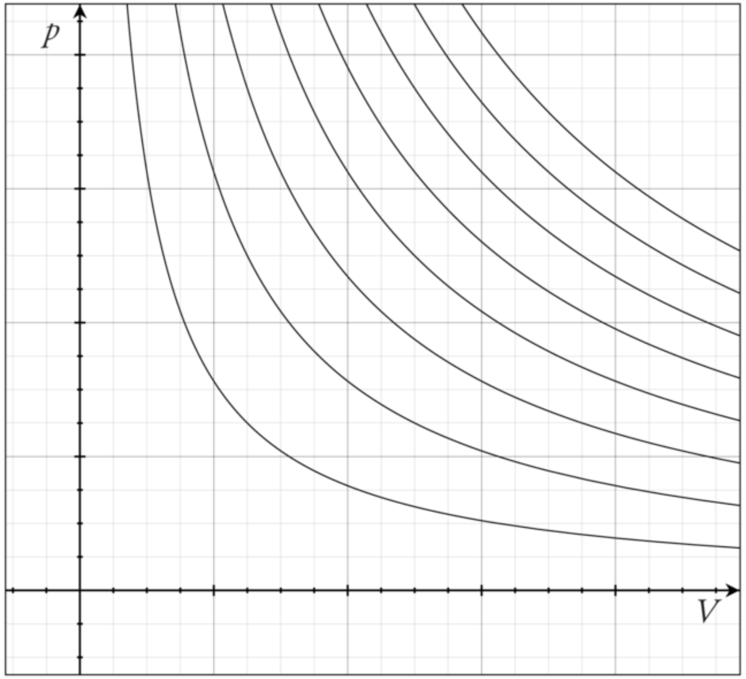
Introduction

- ***Reasons for conversion***
  - ***Physical properties of gas***
  - ***Energy value of 1m^3 depends on the pressure, temperature, and calorific value***
  - ***Price specified per 1m^3 for gas under standard conditions and referent calorific value***
- ***Goals***
  - ***Protection of market participants***
  - ***Comparability of data***
  - ***More accurate natural gas balance***
  - ***More precise data on natural gas losses***

Gas condition



Equation for condition of real gas

$$pV = n\,ZRT$$

- ***p*** – *pressure,*
- ***V*** – *volume (quantity),*
- ***n*** – *number of mol,*
- ***R*** – *universal gas constant,*
- ***T*** – *absolute temperature (K)*
- ***Z*** – *compressibility factor,* $Z = f(p, T)$

$\Rightarrow$ **Volume measured**
must be converted to the same condition parameters
at all system points from entrance into the country to final customers

Characteristic gas conditions

- ***Operating*** – ***real operating pressure and temperature***

- ***Referent condition***

1. ***Standard condition*** – *„s“,*

   T = 288,15 K (15 °C) and p = 1,01325 bar

2. ***Normal condition*** – *„n“,*

   T =273,15 K (0 °C)   and p =1,01325 bar

Conversion of gas volume to standard condition (1)

$$V_s = V_r \cdot \frac{288{,}15}{1{,}01325} \cdot \frac{P_m + P_{atm}}{T_r} \cdot \frac{1}{Z}$$

***V**s*	–	Converted gas volume (m^3) - STANDARD conditions
***V**r*	–	Read gas volume(m^3) - OPERATING conditions
***P**m*	–	Connection pressure (bar) - OPERATING conditions
***P**atm*	–	Atmospheric pressure(bar) - OPERATING conditions
***P**s*	–	Pressure under STANDARD conditions, 1,01325 (bar)
***T**s*	–	Temperature under STANDARD conditions, 288,15 K (15 ℃)
***T**r*	–	OPERATING temperature **(**273,15 + Tgas in ℃) (K)
Z	–	Gas compressibility factor

Conversion of gas volume to standard condition (2)

Gas volume corrector by pressure and temperature –
Device for automatic conversion of volumetric gas flow under operating conditions to standard conditions

Conversion formulae are defined by:
The Rulebook on Metrological Conditions for Volumetric Gas Flow Correctors – MUS.Z-19/1, 1985, Official Gazette of SFRJ No. 9/1985

No corrector available, conversion by calculation according to the same formulae
Corrector by temperature available – no conversion by calculation

The accuracy of operating condition parameters is the problem

Charging natural gas

- ***For gas as an energy carrier, quantity and calorific value are important***
- ***Price 1m³*** *– in methodologies and tariff systems for:*
  - ***Standard gas condition and***
  - ***Referential lower calorific value of gas of 33.338,35 кJ/m³***
- ***To invoice natural gas,*** *the volumetric gas flow must be converted first to*
  - ***Standard condition and***
  - ***Referential lower calorific value of gas***

Calorific value of gas (GCV)

- ***Real***
  - ***varies***
  - ***is determined periodically based on chemical content (quality) chromatographic analysis***
  - ***average (weighted) value is calculated for a specific period, taking into account quantities to which the GCV relates***
- ***Referential – for invoicing***

  To make the data on quantities comparable

Conversion of “standard” to chargeable gas volume

$$V_o = V_s \cdot \frac{H_{pd}}{H_r} \qquad (m^3)$$

Vo	–	***Chargeable volume;*** ***Gas volume converted to referential lower GCV*** *(m^3)*
Vs	–	***Natural gas volume under standard conditions*** *(m^3)*
Hpd	–	***Average lower GCV in an observed period*** *(kJ/m^3)*
Hr	–	***Referential lower GCV*** *(kJ/m^3)* ***actual:*** *33.338,35 kJ/m^3 – agreed on the basis of mean lower calorific value of domestic gas in the seventies*

Conversion to referent calorific value is always done by CALCULATION

Average lower calorific value of gas

$$H_{pd} = \frac{\sum_{i=1}^{n} H_i \cdot V_i}{\sum_{i=1}^{n} V_i} \qquad (kJ/m^3)$$

Hpd	–	***Average lower GCV (kJ/m³) for the invoicing period***
n	–	Number of metering during the invoicing period
i	–	***i*** - metering, on the same day for *Hi* and *Vi*
Hi	–	Measured ***lower*** GCV ***(kJ/m³)*** – deemed to be the same on all days until next sampling
Vi	–	Volume of gas flow between two metering ***(m³)***

Hpd determined by Srbijagas

Analysis of energy entities' practice
before tariff systems implementation (1)

1. ***Conversion to referential condition***

   a) ***not implemented***

   - if the gas delivery via meter without corrector is negligible

   - if not negligible, expected effects of conversion are :

   - ***Integrated into the price*** *(most of the energy entities)*
   - ***Assigned to losses***

   Not correct, and with separation of accounts by activities
   not feasible – costs of loss are born by Operator and not supplier

   b) ***Implemented,*** ***to varying degrees***

   - ***Operating pressure and temperature differently determined***
   - ***Conversion by temperature also with temperature compensator installed - periodically***

Analysis of energy entities' practice before tariff systems implementation (2)

2. **Conversion to referential lower calorific value**

a) ***not implemented***

- *expected conversion effect were integrated into the price*
- *some distributers with high share of domestic gas do not convert by calorific value – the result is unjustified price increase*

b) ***Implemented***

- *Customers/users have doubts about the lower GCV indicated on the bill (e.g. on the basis a subjective assessment of the flame intensity)*
- *Insufficiently transparent*

Problems identified

- ***Area insufficiently regulated***
- ***Different practice of energy entities***
- ***Calculations not transparent enough***
- ***Objective difficulties with determining operating condition parameters***
- ***Referential calorific value is low – for more than 80% of gas, the quantity increases by approx. +2% on the basis of GCV***

Regulating the area

Responsible stakeholders

- ***Energy Agency of the Republic of Serbia***
- ***Ministry of Mining and Energy***
- ***Energy entities (EE) within the gas sector***

Phases

- ***Problem analysis – Agency and EE***
- ***Draft conversion procedure - Agency and EE***
- ***Discussions of professionals***
- ***Amendments to documents – Ministry, Agency and EE***

Agency's participation (1)

In line with its legal jurisdictions specified in Article 15 of the Energy Law:

- ***Collects and processes data on energy entities associated with conducting energy activities***
- ***Monitors compliance with methodologies and tariff systems***
- ***Monitors behavior of energy entities with regard to protection of customers/system users interests***
- ***Processes customers/ system users invoice-related complaints in the context of tariff system implementation***
- ***Monitors the behavior of energy entities with regard to separation of accounts by activities***

Agency's participation (2)

Analysis:

- ***behavior of energy entities with regard to conversion of read to chargeable parameters of gas volume***
- ***experience of other countries***
- ***data availability***

Proposal of :

- ***conversion method - formulae***
- ***method of gathering data***
- ***which referential lower GCV to choose***

Goals in choosing the conversion method (1)

- ***Equal position of market participants***
  - *Mandatory conversion for all metering points without corrector*
  - *The same method of determining operating parameters for all energy entities*
- ***Simplicity of application with sufficient accuracy****

**** - What does sufficient accuracy mean:***

1. *The final result of metering and calculation is as accurate as the least accurate element in the procedure*
2. *When deciding which approximation method to use and when value averaging is done, one should not insist on a precision level that is higher than the requested precision of the metering equipment*

Goals in choosing the conversion method(2)

- ***Invoicing transparency***
  - ***Invoice content***
  - ***Publication of relevant data on the energy entities' and agency's website***
- ***Minimization of differences between read and chargeable quantities***
  - ***Adequate selection of referential values***
  - ***Averaging of effects at the annual level***
- ***More accurate gas balance in the country and comparable data with international statistics***

Determining parameters of gas operating condition (1)

Pm ***- connection pressure***

Simplified for households (and the like)

Germany, Austria, Italy, Croatia: Pm = 22 mbar

Technical norms for interior gas installations:

nominal connection pressure for home gas appliances - 20 mbar,

allowed total pressure drop within LP area (up to 100 mbar) is 2,6 mbar;

Agency's suggestion   ***Calculation*** **Pm = 22 mbar**

for 18 mbar ≤ Pm ≤ 24 mbar

16 distribution uses already 22 mbar

Determining parameters of gas operating condition(2)

P_{atm} ***- atmospheric pressure –*** depends on the sea level

Value used until now:

The most energy entities use P_{atm} = 1003,25 mbar (corresponds to Rimski Šančevi),

Others - up to 1022 mbar

Analysis of the Serbian Hydrometeorological Office (RHMZ)

Based on data of the RHMZ on mean values of P**atm** in 17 cities – distribution headquarters :

- Monthly for 3 years (2005-2007) and
- Annually for 10 years (1998 – 2007),

The minimum deviation is obtained by using the function:

Agency's suggestion **Patm = 1016 – 0,108 * h** (mbar)

Determining parameters of gas operating condition(3)

$P_{atm}(h)$ $h = h_{MMRS}$ – *for all delivery points after MMRS*

Responsibility	*To determine and publish*
Transporter	h_{GMRS} – *for all MMRS towards distributions, until the deadline defined in the Decree*
Distributer	P_{atm} – *for charging customers until the deadline defined in the Decree*

Determining parameters of gas operating condition (4)

Tr ***- Operating temperature***

Energy entities converting according to temperature, apply:

- **Ground T at 1m of depth (**source RHMZ**), maximum - 14 energy entities;**
- **6ºC throughout the year (average winter temp.) - 1 en.entity**

Study of the Technical Department of Novi Sad University

- **Combination of ground temp. and air and T fall due to pressure reduction at the regulator (0,66 Tz + 0,34 Tv – 0,4 Δp) - 2 energy entities,**
- **Combination of ground temp. and air and T fall due to pressure reduction at the regulator(0,75 Tz + 0,254 Tv – 0,4 Δp) - 1 en.entity**

Some international experience: Austria, Italy, Croatia

One mean temperature throughout the year

Determining parameters of gas operating condition (5)

Mean temperature obtained on the basis of mean daily temperature on those days when heating is expected

$$K_T = \frac{T_n}{273.15 + \left(22 - \frac{SD}{BD_G}\right)}$$

K_T	–	**Coefficient of conversion according to temperature**
Tn	–	**Temp. of gas under standard condition, 288,15K**
273,15	–	**273,15 K = 0º C**
SD	–	**degree-day number: Σ(mean temp. inside of the heated premises (20ºC) – mean daily temperatureºC * 1 day**
BD_G	–	**Total heating days** (daily and below 12º C for Serbia)
$22- SD/ BD_G$	–	**Operating temperature** (heating compensates for the difference)

Determining parameters of gas operating condition(6)

Tr - Based on data from RHMZ:

Year		Unit	Belgrade	Nis	Novi Sad
2005	degree-day		2,715	2,840	3,067
	number of heating days		165	168	177
	mean operating temperature	ºC	5.54	5.09	4.67
2006	degree-day		2405	2717	2720
	number of heating days		144	161	163
	mean operating temperature	ºC	5.30	5.12	5.31
2007	degree-day		2,227	2,442	2,639
	number of heating days		160	171	184
	mean operating temperature	ºC	8.08	7.72	7.65
Average	degree-day		2,449	2,666	2,809
	number of heating days		156	167	175
	mean operating temperature	ºC	**6.31**	**5.98**	**5.88**

Determining parameters of gas operating condition (7)

Agency's duggestion: **6 ºC throughout the year**

Public consultation results:

Tr = 6 ºC – Oct - Apr

Tr = 15 ºC – May - Sept

Advantages: Simple application for energy entities and ease of control

Determining parameters of gas operating condition (8)

Z - ***gas compressibility***

Energy entities mostly do not apply that for Pm ≤ 1 bar

Suboticagas, 22mbar: 1/Z = 1,000064
Increases volume for 0,0064%

Gauges with correctors:

Requested data are entered and Z is automatically calculated

Gauges without correctors : $1/Z = 1 + k \cdot Pm$

for Pm<8bar k<0,0032

Pm ≤ 1 bar: Z=1

Agency's suggestion **For conversion by calculation – disregard**

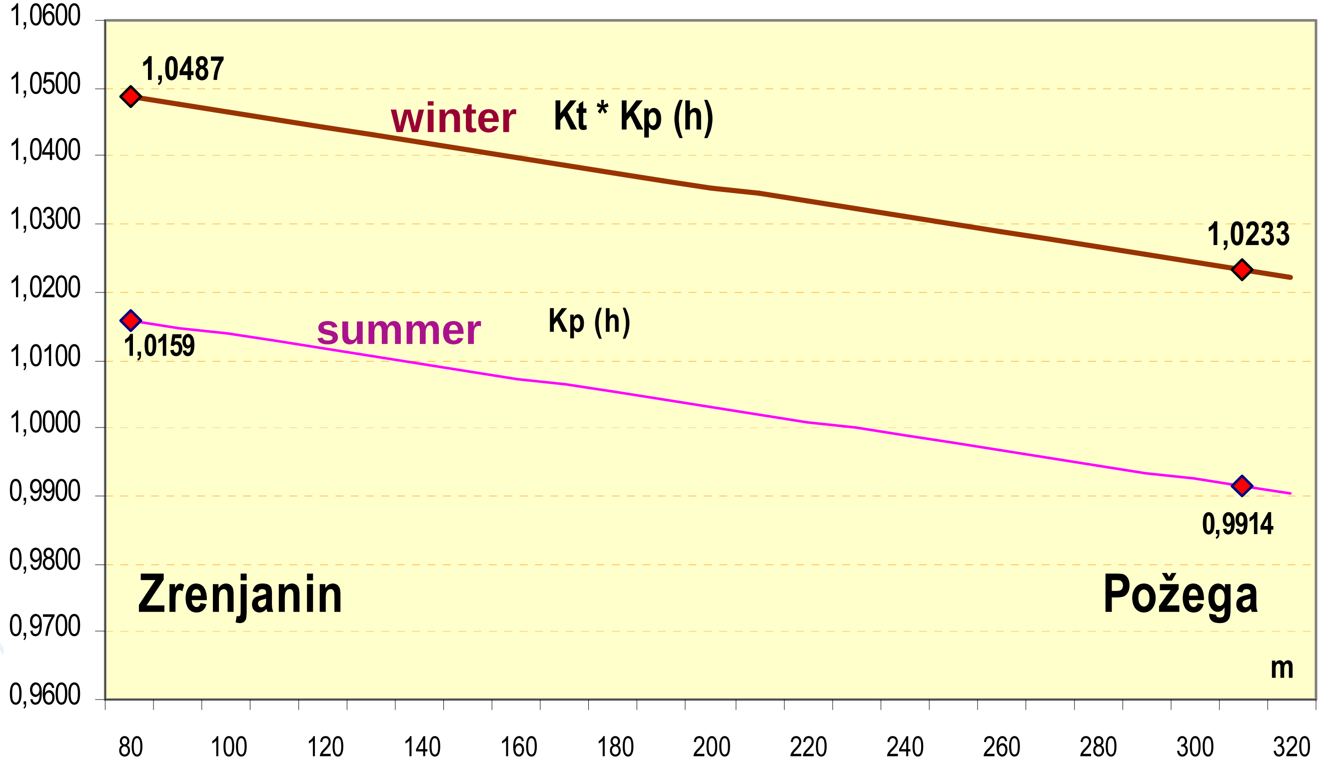
Conversion to standard condition – for households (and similar consumers)

$$V_s = V_r \cdot \frac{P_m + P_{atm}}{P_s} \cdot \frac{T_s}{T_r} \cdot \frac{1}{Z}$$

$$Vs = Vr \cdot k_T \cdot k_p$$

$$k_T = \mathbf{1{,}0322}$$

$$k_p = f(h)$$



Lower calorific value of ga (GLCV)

Agency's suggestion

Hr - referential : three-year average LCV of imported gas

Hpd - real: average LCV of gas - weighted

Public consultation results:

The referential value stays the same until transfer to :

- ***Normal condition, and***
- ***Higher calorific value***

Advantage: *there will be no two changes in a short period of time;*

Disadvantage: *for more than 80% of gas invoices increase by about 2%*

Installation of corrector

Agency's suggestion

1. Corrector installation criterion
   - for Pm > 0,5 bar – a corrector by pressure and temperature is installed, for Pm ≤ 0,5 bar – a corrector by temperature and temperature compensator is installed
2. Correction by temperature is not done, in case
   - the metering device has a corrector by temperature (compensator), or
   - the metering device without a temperature compensator is installed inside the facility

Measuring of gas calorific value

Agency's suggestion

The Natural Gas Transmission Grid Code passed by TSO with approval of the Agency

shall determine:

- The obligation of the TSO to measure the calorific value of gas
  - at certain system points,
  - with certain frequency and accuracy,
  - using a certain method
- The obligation of TSO to report to the stakeholders on daily/periodic calorific values measured

Decree modification initiative (1)

The Agency prepared :

Elements of the amendments

Decree on General Conditions for Natural Gas Delivery

Decree modification initiative (2)

1. **Method of determining operating parameters:**

   Tr, Patm(h), Pr(Pm); Z(Pm)

2. **Application start– as per Decree**
3. **Deadlines for installation of the metering equipment**

Decree modification initiative (3)

Deadlines for installation of the metering equipment:

Metering equipment shall have	Condition	Deadline
Temperature compensator	Pm < 0,5 bar	1. Jan. 2020
Corrector by (P,T)	Pm ≥ 0,5 bar	1. Jan . 2012
Daily protocol recorder and data processing	Pm > 16 bar Transport	1. Jan . 2011
Daily protocol recorder	Q > 500 m^3/h Or Q > 1 Mm^3/god Distribution	1. Jan . 2013

Thank you for your attention

Any questions ?

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